DOCUMENT RESUME

ED 455 106 SE 065 045

AUTHOR	Katz, Phyllis, Ed.
TITLE	Community Connections for Science Education, Volume II: History and Theory You Can Use.
INSTITUTION	National Science Teachers Association, Arlington, VA.
SPONS AGENCY	National Park Foundation, Washington, DC.
ISBN	ISBN-0-87355-192-3
PUB DATE	2001-00-00
NOTE	124p.; Part of the Parks As Resources for Knowledge in Science (PARKS) project, a partnership of the National Park Service, the National Park Foundation, the National Science Teachers Association, and Ohio State University. Funded with support from Exxon/Mobil.
AVAILABLE FROM	NSTA Press, 1840 Wilson Blvd., Arlington, VA 22201-3000. Web site: http://www.nsta.org.
PUB TYPE	Books (010) -- Collected Works - General (020)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Community Cooperation; *Educational Resources; Elementary Secondary Education; *Informal Education; Partnerships in Education; *Science Education

ABSTRACT

Science beyond the schoolhouse is the subject of this close-up look at informal science--education in non-traditional settings, including Boys and Girls Clubs, 4-H, zoos, aquariums, and public television. More than a dozen writers draw on personal experiences to tell why they became informal science educators and how they use the history and theory of traditional science education in their work. Among the features of this book for informal science educators are a resource directory and a special section on program evaluation. Articles include: (1) "The Symbiosis of Formal and Informal Education" (George Tressel); (2) "The Role of Informal Science Education and Learning (with Museums as a Model)" (Lynn B. Dierking and John H. Falk); (3) "National Parks--Exciting Venues for Teaching and Learning Science" (Julia Washburn); (4) "Informal Science Education: A Continuous Part of the Girl Scout Program" (Harriet S. Mosatche); (5) "The Power of Television in Informal Education" (Joel Schneider and Shalom M. Fisch); (6) "The Science Connections in African-American Churches" (Yolanda S. George); (7) "My Changing View of Field Trips" (Vanessa D. Westbrook); (8) "Science Education in Boys and Girls Clubs" (Tom Smart); (9) "4-H-Science from Practical Education" (Elaine Andrews); (10) "Hands On Science Outreach (HOSO): Time for Science Play" (Phyllis Katz); (11) "The Educator's Species: Connecting Conservation and Science Education at Accredited Aquariums and Zoos" (Bruce L. Carr); (12) "The Use of Research and Evaluation in Science Museums and Science Centers" (Peggy Ruth Cole); (13) "Ecology Foundations: Environmental Education in the Field" (Celeste Prussia); (14) "Evaluation: Parks Project Sample--How Do We Assess the Informal Educational Component?" (Emmalou Norland); and (15) "At the Table--A Classroom Teacher and Informal Educator" (Joe Heimlich and Anita O'Neill). (Contains 20 Web site resources.) (ASK)

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Community Connections For Science Education

VOLUME II

HISTORY AND THEORY YOU CAN USE

Edited by Phyllis Katz

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NSTA Press, NSTA Journals, and the NSTA Web site deliver high-quality resources for science educators.

Community Connections For Science Education: History and Theory You Can Use
NSTA Stock Number: PB160X2
ISBN 0-87355-192-3
Library of Congress Control Number: 2001090710
Printed in the USA by Kirby Lithographic Company, Inc.
Printed on recycled paper

NSTA National Science Teachers Association

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NSTA Press
1840 Wilson Boulevard
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Preface

I spent my first years among the concrete blocks of the southeast Bronx in New York City—an early post-WWII baby boomer. My parents took me to the nearby Bronx Zoo, the adjacent botanical gardens, and the museums downtown in Manhattan. I remember gazing up toward the tall ceilings that held the dinosaur bones at the Natural History Museum; the fascinating series of men from small ape-like creatures to the familiar face of modern *Homo sapiens*; and the sparkle of gems and the dioramas of people in lives far removed from the intensity of New York. I remember signing my name on my first library card with great pride—now, I could choose and take out books on my own. I discovered biographies, literature, and the subset of science fiction. Polio vaccines were in their testing stages, and my parents were eager to have me out of the city during the summers, when the dreaded disease still caught more children than at other seasons. Early on, I was sent off to Girl Scout camp, where, among enthusiastic female voices, I learned to swim; canoe; recognize tree barks and leaves; build a safe fire and cook a passable meal over it; and use primitive sanitation. I believe that the confidence that grew in me from those memories, skills, and interests are very much a part of why I am an informal science educator today.

What children experience outside of school counts in their science education. We all know that intuitively. Research and professional reflection confirm this (Bloom 1981; Dierking and Falk 1994; Englehard 1990; Tamir 1991). The strength of my Girl Scout experience had something to do with my sense of what women could do, even though women weren't doing much visible professional science in my early years. My formative experiences led to my career choices, so I see the potential of informal science education.

As George Tressel says in his introduction, informal science education (ISE) is a complement to formal science education in the process of education. As we continue to refine this relationship, we are strengthening and redefining the overall system of science teaching/learning. Perhaps that is one of the reasons that systemic reform has been a catch phrase for over a decade. In their book, *Science for All Americans*, Rutherford and Ahlgren (1989) noted how much the *definition of a system* controls our perception, and what can and should be done.

> Thinking in terms of systems implies that each part is fully understandable only in relation to the rest of the system...Drawing the boundary of a system well can make the difference between understanding and not understanding what is going on. (155–156)

Our expectations of learning potential and educational success are enormously influenced by our experiences or prior knowledge, outside environment, and family support systems. These factors are difficult to quantify, however, when we try to assess the success or failure of a school science program. The statements in *Science for All Americans* immediately preceded both the American Association for the Advancement of Science (AAAS)'s *Benchmarks for Science Literacy* (1993) and the National Research Council (NRC)'s publication of the *National Science Education Standards* (1996). The latter, although directed principally toward school reform, does begin to pick up the theme, and talks of schooling as a system that is greater than the school walls:

> ### Identify and Use Resources Outside the School
>
> The classroom is a limited environment. The school science program must extend beyond the walls of the school to the resources of the community....Many communities have access to science centers and museums, as well as to the science communities in higher education, national laboratories, and industry....Whether the school is located in a densely populated urban area, a sprawling suburb, a small town, or a rural area, the environment can and should be used as a resource for science study. (45)
>
> ### Good Science Programs Require Access to the World Beyond the Classroom
>
> District and school leaders must allocate financial support to provide opportunities for students to investigate the world outside the classrooms. This may mean budgeting for trips to nearby points of interest....It could include contracting with local science centers, museums, zoos...for visits and programs. (221)

This book takes a look at various ISE settings—some found in most communities, some unique to one location. The selection was made to balance a sample of resources likely to be available to many schools (e.g., field experiences, Girl Scouts, the Black Churches Project, Boys & Girls Clubs, public television, 4-H, and Hands On Science Outreach) with unique environments that may have local versions throughout the country or might spark the imagination (e.g., New York Hall of Science, Missouri Botanical Garden, Rock Creek Park, Texas Informal Science Education, and accredited zoos). The authors speak of their joys and their constraints. The challenges of researching our efforts and their value are different from the challenges posed by research in compulsory education. The chapter on evaluation considers an appropriate means to consider these differences. The very fact that this learning is "free choice," according to Dierking and Falk (1994), or that funding is far less assured, as Tressel points out in his introduction, means that the balance of concentration for the informal educator must include attraction as a key element—specifically not the case with compulsory education.

Thus, the ability to attract and sustain interest is a critical tool of such learning. Any theory of informal science education must therefore include an understanding of what motivates people to choose to learn when it is not required. When I tell you later in the book, in the chapter on Hands On Science Outreach (HOSO), that I link its success to basic biology, I echo learning theory on the inherent affective qualities of the learning process: beliefs, values, motivation, and attitudes. We acquire the content of these attributes through repeated experiences with our families, friends, other mentors, and the media, but their motivational property has its roots in fulfilling biological needs to survive through learning.

We acquire our taste for activities through choices that others first make for us, and then those we choose ourselves. Are we given books, subscriptions, and computer software for gifts? Do our families and teachers take us to engaging places like parks, zoos, planetariums, and aquaria to broaden our vistas? Do we talk among ourselves about our interpretations and pleasures and disappointments in what we choose to do? This is the substance of informal education—science and otherwise—its effects are pervasive, long-term, and not so easy to evaluate in our lives.

The goal of this book is to offer an insider's perspective of what informal science settings offer. But it should offer teachers, parents, school board members, and informal educators insights into how these science educators offer their work to the public. One chapter tells us about fields trips; another offers us a new vocabulary for recognizing the opportunity for learning. Other chapters tell us of the history of children's television, or activity programming. Museums and community-based programs describe their approach to inviting out-of-school science education and how it balances with entertainment to attract folks to their facilities and materials. In addition, the authors write about how they found themselves in the informal science education enterprise. These short pieces provide authentic examples of many career routes.

The publishing of this book is important because the National Science Teachers Association (NSTA) has steadily increased its recognition of informal science educators as part of its membership. (See the NSTA Position Statement that follows.) This major step helps bring together the resources of in- and out-of-school educators. Consider these resources in the next phase of planning a unit, a project, or an event that involves students, parents, teachers, and others among the community of learners. Use its references needed for local grants to fund collaborations. Perhaps you will think of using new resources, unnamed, but similar to those in this book.

Acknowledgments

This book and its partner, *Community Connections for Science Education: Building Successful Partnerships*, are part of a project funded by the National Park Foundation with support from ExxonMobil. At the National Science Teachers Association, Linda Olliver designed the cover and layout of both books; and Catherine Lorrain-Hale handled production and printing.

Thanks go to Shirley Watt Ireton and Beth Daniels at NSTA for seeing the book through production; to Janet Frekko and Barbara Griner at HOSO for internal review; to Christine Rodick for providing technical assistance; and to the authors for sharing their love of teaching/learning in these pages and the leadership that paved the path for this book. In 1985–86, Barry Van Deman and the first NSTA Task Force on Informal Science Education brought science teaching beyond the schools within NSTA's borders. Annette Berkovits and Alan Friedman were the co-chairs of NSTA's one-year Task Force on Informal Science Education in 1994–95. The Task Force was followed by an appointed Advisory Board on Informal Science Education, led by myself, followed by Len Sharp, then Bob Russell. The Advisory Board has been replaced by an appointed Standing Committee and is now led by the elected Informal Science Education position on the Board.

The following pre-publication reviewers helped shape the final stages of this book's content. Bonnie Cook, Peter Corbat, and Anita O'Neill of the Montgomery County Maryland Schools provided teachers' perspectives. This book was also enhanced by the expertise of Christie Anastasia and Patti Reilly of the National Park Service; Joyce Meredith, director of Down to Earth Interpretation & Education; Norma Neely, division director of professional development for NSTA, and Mary Miller Smith of the National Audubon Society. Thanks are also due to ExxonMobil for funding the Parks As Resources for Knowledge in Science (PARKS) project. On the home front, I am continually grateful to my husband Victor for the partnership that supports my work, and his, in education.

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An NSTA Position Statement on Informal Science Education

Preamble

NSTA recognizes and encourages the development of sustained links between the informal institutions and schools. Informal science education generally refers to programs and experiences developed outside the classroom by institutions and organizations that include:

- Children's and natural history museums; science-technology centers; planetaria; zoos and aquaria; botanical gardens and arboreta; parks; nature centers and environmental education centers; and scientific research laboratories
- Media, involving print, film, broadcast, and electronic forms
- Community-based organizations and projects, including youth organizations and community outreach services

A growing body of research documents the power of informal learning experiences to spark curiosity and engage interest in the sciences during school years and throughout a lifetime. Informal science education institutions have a long history of providing staff development for teachers and enrichment experiences for students and the public. Informal science education accommodates different learning styles and effectively serves the complete spectrum of learners: gifted, challenged, nontraditional, and second-language learners.

Declaration:

NSTA strongly supports and advocates informal science education because we share a common mission and vision articulated by the National Science Education Standards:

- Informal science education complements, supplements, deepens, and enhances classroom science studies. It increases the amount of time participants can be engaged in a project or topic. It can be the proving ground for curriculum materials.
- The impact of informal experiences extends to the affective, cognitive, and social realms by presenting the opportunity for mentors, professionals, and citizens to share time, friendship, effort, creativity, and expertise with youngsters and adult learners.
- Informal science education allows for different learning styles and multiple intelligences and offers supplementary alternatives to science study for non-traditional and second language learners. It offers unique opportunities through field experiences, field studies, overnight experiences, and special programs.
- Informal science learning experiences offer teachers a powerful means to enhance both professional and personal development in science content knowledge and accessibility to unique resources.
- Informal science education institutions, through their exhibits and programs, provide an effective means for parents and other care-providers to share moments of intellectual curiosity and time with their children.
- Informal science institutions give teachers and students direct access to scientists and other career role models in the sciences, as well as to opportunities for authentic science study.
- Informal science educators bring an emphasis on creativity and enrichment strategies to their teaching through the need to attract their noncompulsory audiences.
- NSTA advocates that local corporations, foundations, and institutions fund and support informal science education in their communities.
- Informal science education is often the only means for continuing science learning in the general public beyond the school years.

—Adopted by the NSTA Board of Directors in January 1998

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Introduction:

The Symbiosis of Formal and Informal Education

George Tressel
Communications Consultant

What is the ultimate goal of education? Is it preparation for a trade, or is it preparation to participate in a fluid, sophisticated society? Both alternatives are important as people are expected to pursue several careers during a lifetime, and employers increasingly ask for workers who can learn, reason, and communicate rather than simply demonstrate a skill. It is no longer enough to do arithmetic on a shopping bag: Show me how to use a computer to solve a problem. It is no longer sufficient to know words like "lepidoptera" and "arthropoda": Tell me why the sky is blue and how to test your explanation. This, after all, is what education is really about.

How can schools educate lifelong learners—informed, curious adults, eager and able to continue learning in a changing world? It is not enough to simply answer "education" or "standards." The words suffice for slogans and demagogues, but persons who work in the classroom know better. Success in education begins at home before the child ever sees a classroom. Continuing success depends on parental interest and support and a million other influences that happen outside the classroom. Enthusiastic children with a rich conceptual "vocabulary" of ideas, words, and practice at learning have a head start and are ready for the challenge and sustained discipline of the classroom. Children growing up in a rich environment for informal learning, who read good books, watch educational television, play learning games, and visit museums, are very likely to become better students.

Education and learning are a *system*. The successful students reflect a combination of innate talent, outside environment, and the classroom opportunity. Both formal and informal education systems pursue an integrated common goal. They build and reinforce a schema of knowledge—a repertoire of concepts, facts, vocabulary, and background to prepare for further learning in life or in a profession. They work to develop enthusiasm and highly individual skills for interpreting, manipulating, organizing, and applying knowledge. Schools cannot do this alone. They need the enthusiasm and reinforcement of students who are *already prepared to learn* at every level.

People Learn Best When They Can Build on What They Almost Know Already.

Students learn best in the classroom when they arrive with habits and concepts acquired outside the classroom. Students learn best when outside experiences reinforce and extend the content and context of their studies. Informal education establishes, reinforces, and broadens the students' base of knowledge and skills and links prior knowledge to their studies in and beyond the classroom. These are:

- **Curiosity.** The excitement of first-hand discovery in places like museums and clubs sets the stage for more disciplined study.
- **Self-confidence.** No one fails in the recreational learning environment. Success here can carry over into the classroom. This is the bedrock of persistence and discipline in formal studies.
- **Experience.** A broad background of "random" information from broadcasting, museums, clubs, hobbies, and other informal activities introduces material before it is encountered in the classroom, and—more important—enables students to develop unique problem solving patterns. These personal perspectives fuel lifelong learning.
- **Reasoning skills.** Informal education activities can help students develop habits of independent learning and problem-solving, so that students will greet problems as challenges rather than obstacles.
- **Zest.** Above all, informal educators are experts at building a zest for learning. Without the burden of a limited curricular focus, they can concentrate entirely on building and honing the "Aha!" factor—the student's enthusiasm and desire to know more about a topic rather than apprehension about a "test."

Thus, formal and informal learning are complementary approaches to a common goal: a lifelong learner with a broad background of knowledge, skill, and enthusiasm for learning. But they are not easily integrated, and it is very tempting to apply the objectives of each to the other. The following chapters document this difficulty and describe how gratifying it is when the collaborations are successful.

Some of the examples and descriptions are particularly provocative. Even though the content is presented in a context of playful exploration and the children span a range of different ages, the experiences of Hands On Science Outreach (HOSO) demonstrate that it is possible to develop a consistent and coherent informal "curriculum" that spans a number of years and a significant range of pre-science topics. One of the weaknesses of informal experiences is the sporadic occurrence and difficulty of building a body of knowledge and insight.

Equally important, the HOSO program demonstrates that many parents place a significant monetary value on consistent, supplementary learning experience. This may be because parents see the show-and-tell items their children bring home from the program, and observe firsthand the learning that is so hard to prove in "evaluations." Unfortunately, conventional educational evaluation tools serve best to prove what can be "tested." The subtleties of "zest," background information, curiosity, and involvement are much harder to describe and weigh—and there are far too few persons like Falk and Dierking to pursue such difficult questions.

In a similar vein, the experiences of the Boys & Girls Clubs and the 4-H clubs show the value of consistent experiences over a period of time. Too often the activities of informal educators are isolated and brief. The Girl Scout Camp-ins that began at the Ohio Center of Science and Industry are an overwhelming example of consistent experiences over time and how eagerly these are received. If more cooperative programs were available with better integration of their content and impact, informal education could indeed became a well recognized complement to the learning of classrooms. This does not happen for many reasons.

The Challenge of an Integrated System

Informal education is torn between pressures to serve the goals of the classroom and pressures to be self-supporting as part of the entertainment milieu. It is ironic that the entertainment success of science centers and educational television should exert ever-greater pressure to compromise content and education for entertainment and affluence. Unlike other museums, the very success of science centers leads to an expectation that they will be self-supporting centers of recreation and entertainment. Similarly, educational broadcasters are exhorted to share the affluence of cable and public service time.

Even classrooms are offered "free" hardware and books. But there is no free lunch, and the roles of both formal and informal education are compromised by pressures to sell and entertain. Formal and informal science learning should be complementary features of a holistic education environment. The role of entertainment is a valuable means to this end and a way to reach all students before and during their educational years. But neither formal nor informal learning should be dependent on commerce for its existence.

The examples in this book remain just that—examples—rather than the norm. The projects of the Children's Television Workshop (CTW), science centers, HOSO, and the Boys & Girls Clubs remain outside the mainstream of science education research. Perhaps this is so because the integration and research of formal and informal learning is so difficult. Or perhaps it reflects a narrow focus on an optimum classroom curriculum rather than an integrated view of the learning environment.

A New Teacher-Training Model

At the turn of the century, the teaching of medicine underwent a transition, from a philosophy and lecture-based system to a practice of educating in large university-operated clinics where research and development in the "dirty" real world of everyday medicine became the norm. This change was critical to the progress of medical teaching and research. Perhaps it is time for a similar change in science education and teacher-training where major universities would affiliate with large school systems and agents of informal education to establish real-world teaching schools analogous to our teaching hospitals. That would not be laboratory-schools. Education students could do internships and teaching research in real-world schools, as any practitioner would during an apprenticeship under the guidance of a master.

The Head Start program, for example, has blended the differences between formal and informal education and serves as one example from such a real-world environment. With models like these in mind, I urge you to read on.

The Role of Informal Science Education in Learning

with Museums as a Model

Lynn D. Dierking and John H. Falk
Institute for Learning Innovation

> The idea that knowledge is essentially book learning seems to be a very modern view, probably derived from the medieval distinctions between clerk and layman, with additional emphasis provided by the literary character of the rather fantastic humanism of the sixteenth century. The original and natural idea of knowledge is that of cunning or the possession of wits. Odysseus is the original type of thinker, a man of many ideas who could overcome the Cyclops and achieve a significant triumph of mind over matter. Knowledge is thus a capacity for overcoming the difficulties of life and achieving success in this world.
>
> — G.S.Brett, 1928

As America and the rest of the world transition from an industrial to a knowledge-based economy, knowledge and meaning-making more than ever before become key to social and economic well-being. Even though the quantity of information grows exponentially all around us, our thirst for knowledge remains unsatisfied. Where can a knowledge-thirsty public turn to learn about science when they are not in school? There are books. Despite the hype about declining literacy, the number of books sold per year is at an all-time high and many are science-related (Achenbach 1999; U.S. Bureau of the Census 1996). There is television. Not only is television viewing up (Godbey, n.d.; U.S. Bureau of the Census 1996), but so, too, are the number and diversity of information-oriented programs, many of them on science topics (Gross 1997). There is the staggering growth of the Internet, a fact we all are aware of; clearly science is being communicated there also (Achenbach 1999;

Schwartz 1998). And, yes, there are science-related museums and other informal science education settings such as zoos, national parks, aquariums, science centers, and botanical gardens. It was not so long ago that the vast majority of Americans would rather have been bound and gagged than visit a museum. Today museums rank as one of the most popular out-of-home leisure experiences in America; people make many visits to science-oriented institutions in their leisure time (Dierking and Falk 1994; Falk 1998; Association of Science-Technology Centers 1999).

Doubtless, the causes for these shifts in the appreciation and popularity of science museums and other informal science education opportunities are many, but we would argue that at the core there is but one essential reason—a desire to learn. Learning is why people choose to participate in these experiences. Our research, and that of others, suggests that learning is so central to these experiences, that we advocate a different term for this learning—*free-choice* learning (Falk and Dierking 1998, Falk 1999; Falk n.d.). Rather than defining the learning by what it is not (formal), or where it occurs, as the term informal learning does, free-choice learning focuses on the characteristics of such learning—nonlinear, personally motivated, and involving considerable choice on the part of the learner as to when, where, and what to learn. Free-choice science learning occurs during visits to museums, when watching television, or while reading a newspaper, talking with friends, or surfing the Internet; it also happens in exemplary classrooms—a topic for another chapter, of course!

People do learn while participating in free-choice science learning experiences; however, providing compelling evidence for such learning has proved challenging because free-choice learning researchers and the public alike have had the wrong search image and were using flawed tools. Many reasons account for this, but the primary reason has been the fundamentally erroneous way learning has been traditionally conceptualized. Perhaps the greatest impediment to understanding the learning that occurs in free-choice situations has been that social scientists, educators, free-choice learning professionals, and the public at large have historically thought of this learning as being similar to traditional formal models of learning, such as the transmission-absorption model (Roschelle 1995; Hein 1998; Hein and Alexander 1998).

This line of thinking suggests that people engaging in free-choice learning should learn the same types of things and in the same manner as do people learning at school; the only major difference is that people will learn less. Take the museum as an example. The standard museum-learning paradigm described above is a good example of this—the visitors are the students and the exhibition is the lesson. Bring the students (visitors) into the classroom (museum exhibition), present them with a lesson, and they will learn it—in the case of the classroom, they will have plenty of time to absorb it all; in the case of the museum exhibition, they spend less time, so maybe they will only get the gist of the message. Truth be known, this model does not work in museums and, of course, it does not work in schools either.

Defining learning is a tricky business. For example, learning is simultaneously a process and a product, a verb and a noun (Falk and Dierking 1995). So slippery is learning as a concept that even the social scientists that study learning for a living—psychologists, anthropologists, and sociologists—have difficulty agreeing on a single definition (e.g., Bransford 1979). Many of these professionals have avoided the dilemma by identifying numerous types of *learning*. For example, some argue that learning occurs when remembering sensory experiences, and that *higher* learning occurs under conditions of instruction such as might occur in a school classroom (Churchland 1986). These taxonomies are helpful for some purposes but have little value for the purposes of understanding free-choice learning.

It is better to think more holistically, to think about learning as a series of related and overlapping processes, appreciating that such systems can be difficult to make sense of because of their complexity and ephemeral nature. By analogy, it is not only possible, but also traditional, to discuss the complex and ephemeral functioning of the human body by thinking of the circulatory, respiratory, and nervous systems as separable and discrete entities. This approach has many benefits, particularly if one does not lose sight of the fact that in a fully functioning, living human, none of these complex systems are in fact separate or discrete, nor can their individual functions be completely isolated without damaging the whole. To understand the living system, it ultimately makes more sense to talk about activities that involve many of these systems simultaneously, such as respiration or digestion. As with this example, there are benefits to a reductionist view of learning, as long as it is ultimately appreciated that *free-choice learning is a whole body, whole brain experience.*

To this end, eight years ago we formulated a framework for thinking about learning that tried to accommodate much of the diversity and complexity surrounding free-choice learning, a framework that at the time we called the "Interactive Experience Model" (Falk and Dierking 1992). In the last year we have built upon and refined this model, recasting it as the "Contextual Model of Learning" (Falk and Dierking n.d.). The contextual model posits that all learning is situated within a series of contexts. In other words, *learning is not some abstract experience that can be isolated in a test tube or laboratory, but is an organic, integrated experience that happens in the real world.* We argue that learning is a product of millions of years of evolution, an adaptation that permits an ongoing dialogue between the whole individual and the physical and sociocultural world she inhabits. Since the contextual model was derived from observations of real people in real settings, it is not surprising that some other thoughtful individuals, before and since, also considered models similar to this one (Lewin 1951; Ceci and Roazzi 1994; Mead 1934; Shweder 1990).

The contextual model involves three overlapping contexts—the *personal* context, the *sociocultural* context and the *physical* context. Learning is the process/product of the interactions between these three contexts. Intentionally, this model of learning is more descriptive than predictive. The power of the contextual model is not that it attempts to reduce complexity to one or two simple rules, but rather that it embraces and organizes complexity into a manageable and comprehensible whole. In so doing, the contextual model successfully accommodates much, if not most, of what is currently known about learning.

The model includes a fourth and very important dimension—time. Looking at free-choice learning as a snapshot in time, even a long snapshot (e.g., the time a visitor spends in a museum or surfs on the Internet), is woefully inadequate. To understand learning—any learning—requires a longer view. One needs to pan the camera back in time and space so that one can see the individual learner across a larger swath of his life and can view the experience within the larger context of the community and society.

It is essential that we document free-choice learning. Historically, we believe that free-choice learning educators and psychologists, as well as policymakers and the public, have found this a challenging task because they have approached the problem incorrectly, quite literally asking a fundamentally flawed question. In museums and schools alike, we have framed the question as: "What does an individual learn as a consequence of visiting this museum, or reading this book, or attending this lecture?" The better, more realistic question is, "How does this museum, book, or lecture contribute to what someone knows, believes, feels, or is capable of doing?" All learning is a cumulative, long-term process—a process of making meaning and finding connections. All educational institutions exist within a larger educational infrastructure. What we know about any particular topic is the accumulated understanding constructed from a wide variety of sources, typically including school; newspapers and magazines; books; conversations with friends, family, and knowledgeable acquaintances; television shows; films; observations in the world; and, often, museums (Falk n.d.; Miller and Pifer 1996; Miller n.d.).

People Do Not Learn Things in One Moment in Time, But Over Time.

Since we have framed the problem inappropriately, we have inappropriately set out to document it. And perhaps more profoundly, since we have framed the problem inappropriately, we have set out to achieve our goals inappropriately as well. Thus, you can neither expect knowledge, beliefs, feelings, or capabilities to be instantaneously constructed, nor can you expect to be able to document that knowledge, belief, feeling, or capability as if it were constructed in one moment in time. *The net effect of this faulty model has been poor practice and poor learning research.*

The learning model we need—the learning model we are outlining briefly in this chapter—is a contextual model that includes a time dimension. The Contextual Model of Learning provides the large-scale framework with which to organize information on learning; inside the framework hang the details. These details are myriad. Using the museum as a case study, as an example of how people learn when they freely choose to learn, one can actually define a very specific set of factors that might influence such learning. After considering the findings from hundreds of research studies, eight key factors—or more accurately, suites of factors—emerged as particularly fundamental to museum-learning experiences:

Personal Context

1. **Motivation and expectations**—People go to museums for many reasons and possess predetermined expectations for their visit. These motivations and expectations directly affect what people do and what they learn.
2. **Prior knowledge, interests, and beliefs**—Prior knowledge, interests, and beliefs play a tremendous role in all learning; this is particularly the case in museums. By virtue of prior knowledge, interests, and beliefs, learners actively self-select whether to go to a museum or not, which type of institution to visit, what exhibitions to view or programs to participate in, and on which aspects of these experiences they focus.
3. **Choice and control**—Learning is facilitated when individuals can exercise choice over what and when they learn and feel like they are in control of their own learning. Museums are quintessential free-choice learning settings. As such, they more often than not afford visitors abundant opportunity for both choice and control.

Sociocultural Context

4. **Within group sociocultural mediation**—The vast majority of visitors go to museums as part of social groups—groups with histories, groups that separately and collectively form communities of learners. All social groups in museums use each other as vehicles for deciphering information, for reinforcing shared beliefs, and for making meaning. Museums create unique milieus for such collaborative learning to occur.
5. **Facilitated mediation by others**—Socially mediated learning does not only occur in museums within an individual's own social group; powerful socially mediated learning can occur with strangers perceived to be knowledgeable. Many such interactions occur with museum explainers, docents, guides, and performers, and they can either enhance or inhibit visitors' learning experiences. When skillful, the staff of a museum can significantly facilitate visitor learning.

Physical Context

6. **Advance organizers and orientation**—Study after study has shown that people learn better when they feel secure in their surroundings and know what is expected of them. Museums tend to be large, visually and aurally novel settings. When people feel disoriented, it directly affects their ability to focus on anything else; when people feel oriented in museum spaces, the novelty enhances learning. Similarly, providing conceptual advance organizers significantly improves people's ability to construct meaning from experiences.
7. **Design**—Whether in exhibitions, programs, or Web sites, learning is influenced by design. Exhibitions, in particular, are design-rich educational experiences. People go to museums to see and experience real objects, placed within appropriate environments. Appropriately designed exhibitions are compelling learning tools, arguably one of the best educational mediums ever devised for facilitating concrete understanding of the world.
8. **Reinforcing events and experiences outside the museum**—Learning does not respect institutional boundaries. People learn by accumulating understanding over time, from many sources in many different ways. Learning from museums is no exception. In a very real sense, the knowledge and experience gained from museums is incomplete; it requires enabling contexts to become whole. These subsequent reinforcing events and experiences outside the museum are as critical to learning from museums as are the events inside the museum.

Individually, and collectively, these eight factors significantly contribute to the quality of a museum experience. When any of these eight are absent, learning is more difficult. Thus, we can use this framework as a concrete model for understanding and facilitating learning within a museum context. Given the highly contextualized nature of learning, the sets of factors that emerge as key to learning in other free-choice learning settings would necessarily differ from that of the museum context. However, a similar approach would yield frameworks for learning in these other free-choice situations. To the extent that we can begin to develop models across the whole range of free-choice learning situations is the extent to which we, as a community, can do a better job of both facilitating and documenting such learning.

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National Parks—Exciting Venues for Teaching and Learning Science

Julia Washburn
National Park Foundation

"This is great! We are having fun and learning toooooooo!" shouts a student at Arches National Park, while running during a science game. The park's Canyon Country Outdoor Education Program engages students in hands-on science lessons that encourage inquiry and are aligned with the *National Science Education Standards* (National Research Council, 1996) and the Utah State Standards of Learning. But most of all, they're *fun!* (NPF 2000)

Canyon Country Outdoor Education is one of many standards-based programs offered to over a million students and teachers every year at our national parks. Yale University historian Dr. Robin Winks once described the National Park System as "the world's largest university…with 362 branch campuses" (NPS 1994). Now more than 380 in number, the parks preserve America's special places—fabulous scenic beauty, important natural areas, and significant historic sites—for the enjoyment, education, reflection, and inspiration of all who experience them. Extremely diverse and reflective of American culture, the National Park Service protects places like George Washington Carver's laboratory at Tuskeegee Institute National Historic Site (Alabama), ancestral Puebloan ruins at Mesa Verde National Park (Colorado), 19th-century industrial cotton mills and canals at Lowell National Historical Park (Massachusetts), endangered wetlands at Everglades National Park (Florida), and the scenic grandeur of Yosemite National Park (California), to name only a few.

The Power of Place

These special places make wonderful settings for teaching and learning because they are *real*—they hold the "power of place" (Larsen 1996). It is a powerful experience

Park Ranger Christine Beekman works with third-grade students at Arches National Park.

to learn about invention or technology in a historic setting such as Carver's laboratory or a working historic textile mill. It is more relevant and effective to explore the components of a real marsh ecosystem than to read about one in a textbook or on the Internet. Parks are powerful classrooms because they are relevant to students' personal lives. Learning experiences at parks can help reveal meanings and facilitate students' understanding of the tangible facts and concepts they learn in school (NPS 1996). Because students have the opportunity to be active learners in park settings, interacting with natural and cultural resources outside the confines of a walled classroom, parks are excellent venues for practicing innovative teaching approaches and techniques such as inquiry, constructivism, cooperative learning, interdisciplinary instruction, and service learning (Washburn et al. 1999). Being able to collect data and make comparisons and predictions for the future is a powerful dimension of what the parks have to offer. Students can investigate a variety of parameters and make predictions about future changes and impacts based on data they and scientists collect. With technology, the ability to compare and contrast ecoregions in real time with subject matter experts is unique. Museums are individual separate units, whereas the National Park System joins together significant natural and cultural resources throughout the country. For these reasons, the national parks naturally facilitate learning environments and experiences that support education reform and align with the National Research Council's *National Science Education Standards* (1996).

National Parks—Long Recognized as Resources for Learning

In 1916, the founders of the National Park Service, Stephen Mather and Horace Albright, recognized the educational power of the national parks and the need to interpret their value and meanings to the American public. The Office of Education was one of the first National Park Service "divisions" they created. Although Mather and Albright's original intent was to build support for the National Park System on the national level through education, the focus quickly shifted to meeting the learning needs of individual park visitors. The popular "ranger programs" that developed are still central to National Park Service education services for the general public, along with indoor and outdoor exhibits and publications. John Cotton Dana, an early leader in museum education and a contemporary of Mather and Albright's, stated, "A good museum attracts, entertains, arouses curiosity, leads to questioning, and thus promotes learning" (1925). These tenets rapidly became true for park-based education. Parks were meant to inspire visitors to connect on a personal level, for visitors to find their own meanings in the place and the stories it embodies, and to leave with a desire to learn more.

National parks continue to be wonderful settings for nonformal learning, providing a wide variety of educational media and ranger-led interpretive programs for park visitors of all ages and backgrounds. However, through the years, the National Park Service's approach to serving the educational community—schools and groups such as scouts and Elderhostel—has evolved. In the 1960s, the environmental movement brought awareness about ecology and the role of park resources in ecosystems. In response, the Service began an initiative to provide national environmental education programs for organized groups. Working with a well-known educational publishing company, the National Park Service created environmental education teaching materials that were distributed throughout the country. Although these publications were beautifully designed and filled with useful information, they were not completely effective. Unfortunately, many schools did not teach environmental studies at that time, and the generic nature of these materials made them difficult for teachers to integrate into classroom lessons. They did not work well for on-site park programming because they were too general (Huggins 1995).

Rather than use these national teaching materials, many parks, like the Everglades, created successful park-specific programs in collaboration with local teachers to meet community needs. These partnership grassroots programs were based on local school science and social studies curricula. When the Service's national environmental education program lost funding, the local programs continued to flourish because of their popularity among teachers, students, and parents. These programs provided exciting venues outside regular classrooms to teach mandated school curriculum objectives, making science and history come alive for students. They offered alternatives to abstract classroom learning, providing a knowledge structure that connected with students' lives (Carr 1989). Today, 30 years later, students in Miami, Florida, continue to participate in programs at the Everglades that literally take them into that "river of grass," allowing students to observe and experience science concepts firsthand, practice inquiry, and become involved with their ecosystem—an integral part of their own community and culture.

Parks as Classrooms®

Today, the National Park Service's education strategy is based on this grassroots model. Parks work in cooperation with local educators to create and present curriculum-based programs and develop interactive educational materials such as "traveling trunks" (kits containing park-related manipulatives, games, and activities) and CD-ROMs for schools and other organized educational groups. These special places are transformed into fabulous "classrooms" where students get to do real science and social studies, use real equipment, and learn concepts that have real-world relevance. As one student at Santa Monica Mountains National Recreation Area (California) enthusiastically put it, "I felt like a scientist today…I've never done this before, and we had all this equipment that I never used before" (NPF 2000).

To facilitate these meaningful experiences, the National Park Service is dedicated to establishing the National Park System as a distinct resource for the education community, thereby increasing connections between national parks and educators. The Service recognizes the educational value of park resources as well as the power educators have to help the American public connect with and understand the natural systems and cultural heritage that the parks protect. This is reflected in the NPS's stated goal to "train teachers to use natural and cultural resource information in classrooms, which would multiply the postive effects….Teachers reinforce the concepts learned through the parks in an interdisciplinary fashion over a period of time, which increases the depth of understanding" (NPS 1997, 7).

Many parks offer teacher workshops and longer, more in-depth institutes, often for recertification or graduate credit. In addition to gaining knowledge and skills for teaching students in new and interesting settings, participating educators have opportunities to "develop strong and lasting connections with park staff members which result in collaboration…and exchange of ideas [that continue] long after the institute's completion" (Washburn et al. 1995, 22). Institutes create synergy between teachers and national park staff. Many park staff are subject matter experts and have access to rich collections of primary source documents, artifacts, or scientific data. Teachers gain access to content while helping park staff ensure that programs for students are well grounded in local, state or national curriculum standards.

> This has been a wonderful opportunity to work with dynamic teachers across the region. It was a time of creativity and professional growth. But getting to work with the National Park Service people has been the highlight. I've learned more about our parks and how to teach in them.
>
> *Participant in a graduate-level teacher institute at*
> *Harpers Ferry National Historical Park, West Virginia*

Parks and Science Education Reform

With advances in science occurring at a remarkable rate, it is becoming imperative that all citizens have a basic understanding of scientific principles and processes. However, many high school science classes are taught much as they were more than 50 years ago. For years, American science education has suffered from a lack of focus. Students are barraged with "information, trivia, and disconnected facts at the expense of a few clear and central concepts and ideas" (Bartels 1999). Growing up, many of us were led to believe that science is only for the mysterious few who seem to be able to remember all the facts or are particularly "brainy." This couldn't be further from the truth! Any observant parent knows that children are innately curious about everything. Toddlers engage in scientific inquiry all the time, observing and exploring their surroundings and constructing knowledge based on their experiences. Science can and should be for everyone. That is the basic tenet of the *National Science Education Standards*—access to science learning is unequivocally for all of us! Parks and other nonformal educational institutions have the opportunity to promote educational innovation because, in many cases, they are already using the methods and techniques that are the backbone of the current school reform efforts. By learning about and embracing the *National Science Education Standards*, national park educators are increasing the value of the learning experiences they create for students and teachers, enhancing the quality of their programs, and promoting scientific literacy for all.

The National Park Service, the National Park Foundation, ExxonMobil Corporation, the National Science Teachers Association, and Ohio State University recently joined forces to integrate the *National Science Education Standards* into National Park education programs. Together they have created the Parks As Resources for Knowledge in Science (PARKS) program. This program is helping 36 parks nationwide partner with local schools to embrace and implement the *Standards* (Washburn et al. 1999).

Teacher Mike Munoz works with students on Lake Powell.

Students from Page, Arizona, work a hoop net at Lake Powell to catch endangered razorback sucker fish.

Education Specialist Joele Doty assists a student at Glen Canyon National Recreation Area.

For example, Glen Canyon National Recreation Area (Utah), a PARKS grantee, has developed a strong partnership with Page High School. As part of their science classes, students help monitor Lake Powell's water quality and work to recover the lake's endangered razorback sucker fish population. *Desert News*, a Utah daily newspaper, reported:

> While other kids at Page High School are wading through the tedium of another classroom lecture, students in Michael Munoz's advanced biology class are doing a different kind of wading. Several times a week, they pull on waders, roll up their sleeves, and tiptoe into nearby Lake Powell.... Teachers everywhere have been trying to figure out for years how to make science fun. At Page High School they seem to have locked onto a...program that actually does it. (Spangler 1999)

The Glen Canyon/Page High School partnership engages students in real-world experiences that get them directly involved with park resources, encouraging them to ask questions, find solutions, and apply scientific concepts. Students are actively involved in resource preservation, immersed (literally) in science, and *are having a great time!* This is science education reform in action.

Park Experiences Promote Learning—What Research Tells Us

Park educational programming is grounded on the principle that students have a better chance of retaining concepts if they are active participants in the learning process. Research reflected in Edgar Dale's Cone of Learning (1969) indicates that students retain 90 percent of what they "say and do" during a learning experience. Participation goes well beyond discussion in park-based learning experiences. For example, during a middle school program at the George Washington's Birthplace National Monument (Virginia), students study the landscape and learn history, geography, science, and math skills when they use replica 18th-century equipment to survey a plot of land that George Washington surveyed at the age of 13. Then students compare 18th-century survey methods with modern Global Positioning System and computer-mapping technologies. They also observe how the land has changed over the centuries, analyze those changes, identify human impacts, and study erosion. To accomplish this, students need to work together in collaborative groups, teaching and helping each other.

Park-based experiences, like the one at George Washington's Birthplace, are in keeping with the North American Environmental Education Association's environmental education guidelines for learning (1999). Students become directly involved with natural and cultural resources, and provide opportunities for learning that encourage investigation and nurture inquiry and problem-solving skills. The very nature and complexity of learning about a place and the dynamic interaction between humans and the land necessitate that park education programs are interdisciplinary. They challenge students to integrate science, math, language arts, and social studies concepts and skills and to apply those skills in real-world settings. Often, park managers can use data that students collect and even inferences students make to inform management decisions. For example, students are conducting a long-term study of frog populations at Kenilworth Aquatic Gardens, a unit of the National Capital Parks in Washington, D.C. Middle school students mentor kindergartners during this innovative multiyear program. Together they learn to identify frog calls and then collect population data for the park using scientific protocols. Because amphibian populations are in jeopardy throughout the world, this longitudinal population data is very important. Staffing and funding shortages make collection of this data impossible without the students' help. Likewise, many students would never be exposed to the beauty and serenity of wetlands without participating in the

Students from Richmond County, Virginia, use 18th-century surveying techniques to replicate one of Washington's early surveys. Ranger Andrew Packett and a team of Richmond County teachers developed the program for the George Washington Birthplace National Memorial.

program. After conducting their field research, the students work together on art and creative writing projects. Their creations reflect the new appreciation the students are gaining for the wetland and river ecosystems that are part of their community, and more important, what those places mean to them personally.

What We Almost Lost

Winding twisting through the woods
the water sparkles and shines
Free of the dirt and mud
that speak of worse times
Free to run and play
through the logs and moss
Reminding many people
of what they almost lost.
—*Middle school student*

Park programs respect students and honor the concept that students are "not passive receivers of information, but active creators of meaning who add new information to the understandings…they already have from previous life experiences" (Lewenstein 1993), thus promoting collaboration among park rangers, teachers, and students and creating a positive environment for learning. Programs provide opportunities for students to construct their own meanings and make very personal connections with the places they study. Gottried's (1979) museum education research indicates that this type of learning experience has academic as well as motivational and social benefits. Participating students become self-motivated, confident learners, and their attitudes toward science improve. Park-based research indicates that park experiences have similar benefits. In a 1997 study conducted at Harpers Ferry National Historical Park (West Virginia), Antietam National Battlefield (Maryland), and C&O Canal National Historical Park (Maryland), students who participated in park education programs scored significantly higher on post-tests than those who studied the same subjects in school classrooms. In addition, students who participated in the park programs indicated that they were significantly more confident in their ability to explain, demonstrate, or in some way convey to others what they learned about science and social studies than the students who stayed at school in traditional classroom settings (Monroe et al. 1997).

Lieberman and Hoody (1998) studied 40 schools that use the "environment as an integrating context for learning (EIC)." These schools embrace the same principles and educational approaches that are central to park-based education. They "attempt to provide students with the opportunity to connect and integrate what they are learning to their surroundings" while engaging in educational practices such as interdisciplinary integration of subject matter, collaborative instruction, emphasis on problem-solving and projects, combinations of independent and cooperative learning, and learner-centered and constructivist approaches. Lieberman and Hoody found that this approach has a profound effect on students, particularly in their mastery of science:

> When compared to their traditionally educated peers, EIC students more effectively master scientific knowledge and skills, and achieve a deeper understanding of scientific concepts and processes. They also perform better on standardized measures of science achievement and demonstrate greater excitement about learning science than students in traditional curricula.... They become more confident learners, assured of their ability to understand new scientific information, to draw conclusions, and to make informed decisions. (45)

Parks and the Future

National parks offer powerful venues for teaching and learning, using the environment as an integrating context. And national park educators are ready partners for promoting educational innovation. As we begin a new century, our national parks are more relevant than ever before. These places of wonder provide refuge and revitalization for the human spirit, offer opportunities to reconnect with nature and our collective cultural history, and help us find personal meanings to make sense of the world. Students benefit from the rich and profound learning opportunities abundant in the parks. As naturalist and historian Enos Mills wrote in 1917, "...these parks [remain] the greatest of schools and playgrounds. No other school is likely so to inspire children, so to give them vision and fire their imagination. Surely the children ought to have this extraordinary opportunity" (366).

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Informal Science Education: A Continuous Part of the Girl Scout Program

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Girl Scouts of the U.S.A.

The year is 1913 and the first Girl Scout handbook called *How Girls Can Help Their Country* has just been published—one year after Girl Scouting was started in the United States by Juliette Gordon Low. Along with the expected sections on camping, homemaking, and crafts are numerous references to science activities and the scientific method. At a time when women had not yet been granted the right to vote, girls were being asked to "Get to know by sight and sound as many birds as you can. Jot down in your note-book the dates of arrival and also 'last seen' of all the summer and winter visitors. It is valuable information for the Biological Survey at Washington and they will furnish blanks and return envelopes to all who are willing to assist them in making observations" (48).

Along with the focus on observation, Girl Scouts were taught about the role of classification in science. "Now let us look back and see what all this Nature study teaches the Scouts in their course of training as Scouts. First and foremost is the habit of careful and close observation—not only how much we can see but how correctly we see it. Second are habits of order—we group our knowledge in the best and most scientific manner. We have a regular plan of procedure" (53–54). In that handbook, girls were also asked to conduct systematic experiments. "Watch the growth of any little house plant and see the effect of different soils and temperatures upon it" (52). A chapter on stars contained a piece on using stars to determine time with diagrams and precise calculations. A section on creating a sundial helped girls understand the difference between "sun time" and standard time. A first-aid section in the Health chapter provided scientific explanations of procedures and also contained information on the function of the heart and the lungs.

Less than a decade later, a revised handbook, *Scouting for Girls*, was published and provided detailed directions for passing "Proficiency Tests" in a number of science areas. For example, to receive the Electrician Proficiency Award, girls were required to explain the use of magnets for attraction and repulsion; describe the use of electricity in the electric bell, telegraph, and telephone; and demonstrate how to connect two batteries in a series with a bell and push button. Selected resources on relevant science topics were also provided to help girls find information that would allow them to complete the requirements.

A Zoologist Proficiency Award was also available in the 1920 handbook. Understanding the differences between plants and animals, between vertebrates and invertebrates, and among the various types of vertebrates was necessary to pass the test on this topic. In 1927, the National Executive Board approved new requirements in the field of Nature. Merit badges became available for studying one of the following careers: geologist, astronomer, zoologist, ornithologist, or entomologist. And two years later, an article in the *Girl Scout Leader,* written for the adults who worked with girls, included an article titled "What and Why Are Crystals?" Definitions and explanations of "the atomic structure and molecular arrangements," along with directions for making crystals, were detailed to encourage Girl Scout leaders to bring this topic to the attention of girls. That same year, an article in the magazine informed readers about an exhibit of Girl Scout nature activities that would be shown at a joint meeting of the American Nature Study Society, the American Nature Association, and the American Association for the Advancement of Science.

In the handbook of the 1930s, Girl Scouts were asked to judge weight and height and to know the speed of sound and light. Detailed information about trees and nutrition were other topics covered in that book. In 1938, three Girl Scout age levels were established, the youngest being the Brownie Girl Scouts, more commonly called the Brownies. Girls who were as young as seven were exposed to science through the Girl Scout program.

When the handbook of the 1940s was published, long-term projects in science were included. For example, to receive the Wild Plant Finder badge, girls were required to record plant life in one small area for six months or more, while they were required to "go out at night several times to see how many different kinds of night-flying insects" they could see to earn the Insect Finder badge. Chemistry was also covered in this book, with Girl Scouts asked to "choose at least 10 of the common elements and discover their uses and some of their combinations...." One article that appeared in the *Girl Scout Leader* in 1947 encouraged leaders to work with girls on aviation activities, including helping them to discover how an airplane takes off and moves through the air. The following year, the magazine included an article that suggested that leaders help girls learn about herpetology—the study of snakes and reptiles.

By 1953, the *Girl Scout Handbook* contained the following science badges: Weather, Conservation, Rock and Mineral, Star, Insect, Tree, Salt Water, and Food. An exciting opportunity for 85 Senior Girl Scouts was provided by the Challenge of Science Program that took place in December 1959 in the Research Triangle area of North Carolina, the area bounded by Duke University, the University of North Carolina at Chapel Hill, and North Carolina State College. The Girl Scouts, who had been selected on the basis of their interest in science, joined 73 Boy Scouts to meet scientists, learn about science training at the university level, become acquainted with science equipment such as electron microscopes, and even to find out about the role of computers in doing research that would have been impossible earlier. The conference, entitled "Horizons Unlimited," had indeed given girls a glimpse of some new study and career possibilities.

A 1960 "Working Statement on the Role of Science in Girl Scouting" from the Girl Scout Program Department suggested: "In Scouting is the chance for adults to help girls to: (1) apply the scientific approach to questions (observation and verification) as a basis for decisions; (2) consider the sciences when exploring vocations; (3) make use of science principles and knowledge in doing activities, including service ones" (Girl Scouts of the U.S.A., 1960). The memorandum also noted that "Girl Scouts of all ages need to be aware that science exists in all program fields." True to that perspective, the 1963 *Brownie Girl Scout Handbook* contained information about the senses and provided girls with opportunities to practice observation and take an animal homes' hike. Science was indeed being infused in various program fields.

The decade of the 1970s introduced new badges and publications for girls and their leaders, encouraging them to explore five areas of activity: personal well being, people, science and technology, the arts, and the out-of-doors. The national project Eco-Action helped girls understand the broad range of environmental interconnections. As part of the national "wider opportunities" program, girls across the country toured space centers, enjoyed archaeological digs, and explored career options in fields such as engineering and aeronautics. When *From Dreams to Reality: Adventures in Careers* was published in 1978 for girls from 12 to 17, Girl Scouts learned about careers in many different science fields. Following studies that suggested that girls between 6 and 11 limited their career aspirations to a narrow range of traditional options, *Careers to Explore for Brownie and Junior Girl Scouts* was published in 1979 to expose girls in that age range to careers in less traditional areas.

The 1980s brought with it a unique science opportunity for Girl Scouts—the chance to participate in the Antarctic Research Project in cooperation with the National

Science Foundation (NSF), a project that has been repeated several times in subsequent years. Another collaboration—this one with the Children's Television Workshop—produced guidelines for using the popular science TV series *3-2-1 Contact!* as a resource for science-related badge activities. In 1987, *Into the World of Today and Tomorrow: Leading Girls to Mathematics, Science, and Technology* was published to foster girls' participation in the increasingly important world of science.

Today, Girl Scouts are involved in science through numerous national events, projects, and publications. Since 1992, the National Science Partnership for Girl Scouts and Science Museums (NSP) has been administered jointly by Girl Scouts of the USA (GSUSA) and The Franklin Institute. Initially funded by NSF, this project uses science kits and training of adult volunteers to bring hands-on science to girls in homeless shelters, activity centers, troops, and camps. The Girl Scouting Beyond Bars program, which allows girls to visit their mothers in prison, has used NSP kits to bring mothers and daughters closer through a joint experience in science. The GSUSA/Franklin Institute-administered Girls at the Center (G.A.C.) project began in 1996 with the support of NSF to encourage family involvement in girls' science learning, particularly those families that have limited experience with science. By providing translations of materials into Spanish, including G.A.C. Packs that contain activity cards for home use, this project has reached many families whose dominant language is not English. Another Girl Scout science resource—*Fun and Easy Nature and Science Investigations*—was produced in both English and Spanish to promote experience with science among girls ages five through 17. A bilingual activity booklet on the same topic, but with different activities, was published for girls ages six through 11, an age level that is critical for reaching girls in the area of science.

As the new millennium unfolds, Girl Scouts will continue to foster positive attitudes about the importance of science and to provide national and local projects that promote involvement in science and technology guided by the following:

1. **Girl-adult partnerships** where girls play a central role in determining their educational experiences supported by caring adults
2. **Cooperative group experiences** that foster experimentation and learning
3. **Trained adult volunteers** who support girls as they explore science and new technologies
4. **An all-girl environment** that encourages girls to take risks in learning and leadership.

In 1912, the first few Girl Scout troops began to observe, question, and investigate nature. Today, more than 2.7 million girl members attend computer camps, explore the physics of amusement park rides, and make polymers. The Girl Scouts of the U.S.A. continues to encourage millions of girls to grow into women who are competent in science and appreciate its role in our world.

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The Power of Television in Informal Education

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Television is arguably the most influential of the popular media. Acknowledged in its power to reach people though engaging programming, television is naturally an attractive tool for those who want to educate, as well as to influence and to inform. While many agree that television programming is successful as an educational tool, they do not agree on the value of the results. For example, some social critics claim that television programming educates children in the ways of consumerism, sex, and violence, and indeed, a large body of evidence indicates that exposure to television violence produces significant effects on children's behavior and attitudes toward violence (e.g., Wilson et al. 1997). Other critics simply decry the pervasiveness of television in our culture. Sorting out causes and effects and the overall role of television in the culture is part of a much wider debate. For the purposes of this chapter, we simply note that most of the educational effectiveness of television overall is an unintentional by-product of programmers' attempts to create engaging and entertaining material.

Our brief discussion focuses on the use of mass-market, commercial broadcasting techniques and styles for intentional educational purposes. This was the approach that Joan Ganz Cooney adopted more than 30 years ago when she led the production of *Sesame Street. Sesame Street* aimed to provide a vehicle for young children to learn cognitive and social lessons that would help ready them for school. It was successful in its educational goals and continues today to deliver an expanded curriculum to children. Data from numerous research studies have demonstrated that exposure to *Sesame Street* results in significant educational benefits for preschool children and that these effects endure over a period of years (Fisch and Truglio 2000).

The success of *Sesame Street* in achieving its educational goals gave Children's Television Workshop (CTW)—and, later, other producers—the courage to replicate the model and means with varying degrees of fidelity. They broadened the target-age range of their attempts and took on difficult and substantive content, including science and mathematics. To date, CTW has produced three television series on science or mathematics: *3-2-1 Contact, Square One TV,* and *Cro*. (Among the science series created by other producers in recent years are *Bill Nye, the Science Guy; Beakman's World;* and *Magic School Bus*.) Research has shown that CTW's initiative was rewarded in the benefits these programs held for children, as discussed in the section on "Educational Impact" below.

CTW Television Series

Broadcast daily from 1980 to 1992 on PBS, *3-2-1 Contact* was a magazine/documentary show for eight- to 12-year-old children that dealt with a broad range of science topics. The ultimate library comprises 236 half-hour programs and 11 hour-long specials. Broadcast daily from 1987 to 1994 on PBS, *Square One TV* was a comedy variety series (also aimed at eight- to 12-year-olds) dealing with middle school mathematics. Its library comprises 230 half-hour programs and 10 hour-long specials. Broadcast as part of ABC's Saturday morning schedule from 1993 through 1995, *Cro* was an animated action/adventure series dealing with the mechanics of simple tools. The impetus for the production of these three series was the general perception that science and mathematics education in the schools were failing to hold the interest of large numbers of children. The theory at work was that regular exposure to the subject matter embedded in attractive television programming could result in improved attitudes toward subject matter. This, in turn, would prove advantageous in school.

Some Rules for Production

Like other programs for informal science and mathematics education, educational television series have a definite constraint when compared with school programs: Participation in informal programs is voluntary. That is most emphatically true of television viewing. This fact demands that educational television programs be, first of all, attractive and engaging so that they can compete with all of the other available programming, most of which does not carry an educational burden. Without an audience, no broadcaster will carry a show. Without an audience, there is no hope for any positive educational effects, no matter how significant or worthwhile the content. For this reason, we at CTW judge our shows first by their appeal to the target audience and secondly by the salience of the content.

To create programs that are both educationally effective and engaging to children, CTW developed a collaborative model of television production that has come to be known as the CTW Model (e.g., Mielke 1990). The model brings together three distinct groups: production, research, and content. The production group consists of the full range of specialists in television production. The researchers are specialists in child development, psychology, or communications. The content group consists of experts in the subject area of the field under consideration in the series. Under the model, development of a major project usually proceeds through several stages. Pre-production seminars bring together producers, educators, and researchers to define curriculum goals and objectives and to explore production formats that might be effective to meet the objectives. While writers and producers prepare scripts and other materials, content specialists and researchers collaborate to help to refine the production formats while melding them with the educational imperatives and attending to the needs and capabilities of children who will benefit from the product.

In early stages of production, researchers test elements of the format and design to help refine the production. In some cases, this process entails assessing children's reactions to prototypes of program elements (e.g., sketches of character designs, and storyboards of proposed scenes or stories) or similar material that already exists. Researchers gauge children's existing knowledge and misconceptions about the educational content being addressed to guide the creation of scripts and stories. Often, however, there is not enough time to collect empirical data to inform the decision process. In such cases, researchers rely on their cumulative expertise, acting as advocates for children. As finished pieces emerge, researchers test them for appeal and comprehension. With series production complete, researchers investigate the educational effectiveness of individual shows. Throughout the production process, content specialists see to it that the curricular goals and objectives are clear and evident in all aspects of the execution. [For an account of the model in practice, see Schneider and Esty (1990).]

Educational Impact

Having discussed the context, constraints, and production of television series about mathematics and science, the question that follows naturally is whether they work. That is, can television programs function effectively as tools for informal science and mathematics education? Empirical research on the impact of *3-2-1 Contact*, *Square One TV*, and *Cro* shows the answer to be a resounding "yes."

3-2-1 Contact. Research on the impact of *3-2-1 Contact* is somewhat limited by the methodologies used; almost all of the studies that have been conducted rely largely on pencil-and-paper (typically multiple-choice) quizzes to assess comprehension and on pencil-and-paper checklists (e.g., concerning occupations that children would like to have or that they believe involve science) to assess impact on science interest rather than on interview methods that might provide richer portraits of children's knowledge and attitudes.

Despite this limitation, however, these studies have consistently found that extended viewing of *3-2-1 Contact* resulted in positive effects on children's comprehension of the science topics presented, as reflected in significant increases in viewers' performance on pencil-and-paper quizzes (Cambre and Fernie 1985; Johnston 1980; Johnston and Luker 1983; Wagner 1985). Moderate, and less consistent, effects have been observed on children's interest in science and images of scientists, although it is not clear whether *3-2-1 Contact* had less impact in this area or whether the more moderate effects were a function of the relatively limited measures used.

The effects of *3-2-1 Contact* were often strongest among girls, who have often been found to demonstrate lower levels of science achievement (e.g., Levin, Sabar, and Libman, 1991).

Square One TV. Several summative studies have gauged the impact of *Square One TV* on its viewers (Peel et al. 1987; Schauble and Peel 1986). The most powerful of these studies was an experimental/control, pretest-posttest comparison of viewers and non-viewers of *Square One TV* (Hall et al. 1990; Hall, Esty, and Fisch 1990) that assessed the series' impact on children's problem-solving behavior and attitudes toward mathematics.

In this study, one group of fifth-grade students in Corpus Christi, Texas (where *Square One TV* had not been broadcast), viewed 30 episodes of *Square One TV* over a period of eight weeks, while a second group (individually matched with the viewer group for sex, ethnicity, socioeconomic status [SES], and performance on a standardized mathematics test) did not. Both groups participated in extensive, task-based interviews that assessed their mathematical problem-solving behavior and attitudes toward mathematics, before and after the treatment period.

Data from the study revealed that viewers of *Square One TV* showed significant gains in the number and variety of actions and heuristics they used to solve problems (e.g., looking for patterns and transforming problems), as well as in the mathematical completeness and sophistication of their solutions. Nonviewers, by contrast, showed no significant gains. These effects occurred regardless of the children's sex, ethnicity, SES, or performance on standardized mathematics tests.

Effects on attitudes fell within several domains. Some noteworthy effects were the following. Viewers showed a broader conception of what "math" is (i.e., beyond basic arithmetic) than nonviewers, a greater desire than nonviewers to pursue challenging mathematical tasks, and significantly greater gains than nonviewers in the number of times they spontaneously talked about enjoying mathematics and problem-solving throughout the interview (i.e., without being asked directly about enjoyment). Again, there was no consistent effect of sex, ethnicity, or SES.

Thus, the data indicated that *Square One TV* was successful in exerting a significant effect on children's problem-solving behavior and attitudes toward mathematics. In particular, the series exerted a significant effect on girls and minority children, two populations that have been considered to be "at risk" for mathematics education (NRC 1989).

Cro. Perhaps the strongest evidence for the effects of *Cro* comes from a summative study conducted after its second season (Fay et al. 1995; Fisch et al. 1997). This study adopted an experimental/control, pretest/posttest design in which children who viewed eight episodes of *Cro* were compared to nonviewers who watched eight episodes of an animated educational series about geography (*Where on Earth Is Carmen Sandiego?*) instead. The study used multiple measures to examine *Cro*'s impact on children's interest in and understanding of science and technology.

The results showed significant differences between viewers and nonviewers in their understanding of the technology content of four episodes of *Cro* (i.e., all of the episodes tested for comprehension). As in the case of *3-2-1 Contact*, these effects were often strongest for girls, one of the populations deemed to be "at risk" for dropping out of science.

Cro was also found to produce various significant effects concerning interest in science. For example, *Cro* viewers showed significantly greater pretest-posttest gains than nonviewers in their interest in doing technology activities that were related to episodes of *Cro* they had seen (e.g., making a catapult), exhibited greater interest in learning more about the technology content of particular episodes, and were significantly more likely to engage in hands-on activities connected to two of the episodes when given a choice among these activities and other, nontechnology activities.

Conclusion

Taken together, these studies demonstrate the power of television as a tool for informal education in the areas of mathematics, science, and technology. Well executed educational television can reach populations that traditionally have been underserved in science and mathematics education. It can have a significant impact on viewers' knowledge, operational skills, and attitudes toward the subject matter. By enhancing attitudes and skills as well as basic knowledge, it can, hopefully, provide viewers with a basis that extends beyond simply acquiring the specific information presented and provide a springboard for lifelong learning.

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The Science Connections in African-American Churches

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African-American churches have generally played a leadership role in many secular issues that serve the needs of their communities. They have served as the staging ground for protest marches, as headquarters for voter registration drives, as recruitment centers for the unemployed, as soup kitchens for the hungry, and as developers for housing and nursing home alternatives. Today, many government and nongovernmental agencies turn to these and other faith-based communities to disseminate or implement programs for youth and adults, including after-school education activities.

In 1986, in search of community-based learning systems outside of schools to support science, mathematics, and technology (SMT) education in schools, the American Association for the Advancement of Science (AAAS) Directorate for Education and Human Resources (EHR) Programs turned its attention to understanding services and resources provided by faith-based communities. Based on an earlier study as well as a concurrent study of precollege SMT intervention program for minorities, women, and children with disabilities, AAAS surveyed a sample of the then 65,000+ predominantly African-American churches (George et al. 1989; Matyas and Malcom 1991).

With responses from a fraction of these churches (380 ministers) we began to learn how to implement SMT programs in churches. AAAS programs and materials developed for use in churches are focused on pre-K to eighth-grade students and are based on the AAAS Project 2061 Benchmarks for Science Literacy (1993) and the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics (1993). Science themes include water and color; shapes and designs; motion in science; electricity and magnetism; and health/life sciences. Mathematics themes include rational numbers, patterns and symbols, geometric/spatial reasoning, and probability and statistics (George, Daniel, and Malcom 1993; George et al.1994).

Similar to other types of informal science education, such activities foster discovery and collaborative work and can be used in after-school settings, summer programs, church fairs, career days, or sermons. In terms of facilities, activities can be done indoors or outdoors. In smaller churches, we have conducted activities in church halls and sanctuaries.

Since the initial study, "Saving Minds: Black Churches and Education" (George et al. 1989), 51 Black Church Coalitions in 33 cities have conducted a range of SMT activities. These coalitions represent 4,500 churches, as well as church-based, education, and professional SMT organizations. Sites are located in 21 states (about 70% southeastern and eastern states) and in the District of Columbia and the U.S. Virgin Islands. As the AAAS Black Church Project has grown and responded to K-12 education reform, we:

- resurveyed a random set of churches in 1994 and received 296 responses.
- conducted focus groups in 1998 in five cities with 123 key religious, early childhood, and community leaders to discuss standards-based preschool and after-school programs that are linked to school, home, and community. Focus group sites included Baltimore, Md.; Birmingham, Ala.; Indianapolis, Ind.; Rochester, N.Y.; and Seattle/Tacoma, Wash.

In addition, we commissioned case studies centered on how AAAS materials were being used (1994 and 1996) and document reviews of reports submitted by churches (1997). Case studies were conducted by Willie Pearson of Wake Forest University, N.C., and document reviews were done by Paula Quick-Hall, currently at Bennett College, N.C.

It is important to mention that besides our own research, this work is guided by research on preschool and after-school studies that indicate:

- High-quality preschool experiences with educational components that help children acquire skills in language, logical reasoning, problem solving, and communications boost students' academic achievement and social adjustments in primary and secondary school settings (Entwisle and Hayduk 1982; Berrueta-Clement et al.1982; Carnegie Corporation of New York 1992).
- Children's early experiences in preschool centers and the home affect their

brain development and their ability to learn and reason (Chugani 1993; Kolb 1989; Carnegie Corporation of New York 1994).

- Children in after-school education programs demonstrate improved academic achievement and more positive attitudes toward school and their peers (Miller 1996).

Although no one can provide the exact number of churches engaged in preschool or out-of-school activities, we know a significant number are involved in these activities. Of the nearly 82,000 daycare centers in the United States, about 12,000 or about 15 percent are in churches or synagogues (Market Data Retrieval 1998). Like other organizations that house or operate child care centers, churches and synagogues are seeking ways to develop, implement, and support high-quality child care programs that include both educational experiences and support for families. To this end, the Ecumenical Child Care Network (ECCN), under the auspices of the National Council of Churches, produced "Congregations and Child Care: A Self-Study" (1996), with the assistance of staff from the National Association for the Education of Young Children (NAEYC).

Also, the U.S. Department of Education National Study of Before- and After-School Programs (1991) indicates that of the nearly 50,000 programs identified, churches represent about 3,000 or six percent of organizations offering after-school programs.

What We Have Learned

- Faith-based educational programs are just as likely to serve children in the neighborhood as children within the church membership.
- K–12 teachers, health professionals, and other professionals with SMT training primarily implement SMT programs. Also, SMT college students and high-school students with a strong interest in SMT play a significant role in leading activities.
- As indicated in Table 1, the emphasis of much of the programming in African-American churches is on tutoring or homework assistance. Remedial activities are a large part of programming, even when technology is available.
- Over one third of the survey respondents in Table 1 indicated that they sponsored field experiences to science museums, zoos, or botanical gardens.

Table 1. Survey results of church-based educational programs

Which of the following activities are included in your church education program?	% of programming
Tutoring in mathematics	35%
Tutoring in science	26%
Tutoring in other subjects	33%
Field trips to science museums, zoos, botanical gardens	38%
Environmental sciences programs	3%
Preschool activities that include education	20%
Joint education programs with public schools	14%

Data was collected in 1994, N=296

- Although 44 percent of the respondents in our 1994 survey indicated that their ministers served on local, state, or national education committees, our focus groups indicated that most church leaders are not aware of research on preschool and early childhood learning.
- From commissioned site visits and interviews with parents and students, we do have anecdotal evidence that the children are learning as indicated by their abilities to clearly articulate the substance of both the experiments and lessons. This was observed from class discussions and when the evaluator asked students to explain a given exercise or activity.

Taking into account the SMT reform that is occurring in schools throughout the country and the research on after-school and computer-based programs, there is a need to design informal science education strategies for use in faith-based and other out-of-school programs that strengthen learning in science classrooms. Such strategies should take into account the need to:

- **Align informal science education programs more closely with standards and school implementation of these standards.** This does not need to be a day-to-day alignment, but rather an enhancement of the in-school activities.
- **Provide informal science education activities that help to build student assessment or test-taking skills.** These skills are the same as the student performance indicators included in the science education standards.
- **Link informal science education activities to homework.** The Condition of Education (NCES 1998) indicates that at least once a week in the school year 1994–95, more than 60 percent of public elementary teachers

assigned routine exercises, readings, or short writing assignments while a little over 29 percent assigned work on a project, data gathering, or conducting an experiment. Less than 17 percent assigned written reports, problems with no obvious solutions, or oral reports.

- **Design informal science education print and Internet materials that have clear links to reading and language-reasoning skills.**
- **Design informal science education print and Internet materials that can be used in the home**—with caretakers who have limited science education but life experiences related to health and medicine, utilities, communications technology, automotives, appliances, household chemicals, weather, plants, animals, and other natural phenomena.

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My Changing View of Field Trips

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When I was a new teacher, my view of field trips was quite different than it is now. Imagine an elementary school in which students take a field trip to an off-campus site such as a museum, zoo, or nature park. The event occurs at the end of the year when textbooks have been returned, state assessments are over, and money remaining from the school's annual budget needs to be spent. Although the teacher has taken students to explore an off-campus site, very often the students use this time in the informal science institution to socialize and only quickly glance at the exhibits or specimens. In this article, I describe how, in my position in the Informal Science Education Association of Texas, I have come over the years to change this scenario.

The Informal Science Education Association of Texas defines informal science education as "providing unique learning environments that increase appreciation and understanding of science, mathematics, and technology and their applications through voluntary and often self-directed experiences for individuals of all ages and backgrounds" (Texas Statewide Systemic Initiative 1998). For the school kids to make educationally sound use of these unique learning environments, it is clear that new views and attitudes must be put in place before the actual field trip. What must an educator offer to ensure that the field experience is an important conduit for learning? What measures should be taken to ensure that informal science education institutions provide students with experiences that enhance learning? Looking at the teacher, the student, and the institution, we will examine the elements that must first be in place for the students to have a positive learning experience.

Years of teaching in the classroom, numerous courses in graduate schools, many professional development experiences, and interactions in different types of informal science institutions changed my thinking with respect to field trips. My evolving attitude influenced the students' view of field trips. Their expectations of a field trip generated learning experiences that connected exhibits and programs to what was going on the classroom. The exhibits and programs offered improved my ability to use informal sites to provide my students with meaningful experiences. The result of this whole process has, in fact, changed the phrase "field trip" to "field experience."

Field experiences are important components to the learning of science (Charles A. Dana Center 1999). As Dorian Reynolds, a Houston teacher said, "My collaborations [with informal science education institutions] are far more then just a field experience, but a component of the learning experience which actively involves students and experts from a variety of areas." From the teacher's perspective, understanding the exhibits and programs available at an informal science education site is a prerequisite for providing a continuing learning experience that extends from the classroom. Through professional development opportunities offered by the informal learning institution, teachers can greatly enhance their ability to connect learning from the classroom to the informal science site and vice versa. According to Brooks and Brooks (1993), "in order for learning to take place in schools, teachers must become constructivists… they must provide a learning environment where students search for meaning, appreciate uncertainty, and inquire responsibly" (7).

The teacher's familiarity with the informal science education site's staff, facility, and exhibits increases the likelihood that instructional planning may include visit(s) to a site that specializes in the topic(s) being investigated. My first experience with the use of informal science education institutions occurred after a few years of teaching in the field. The whole idea of using informal learning institutions as a resource to enhance a lesson or unit would perhaps seem a little overwhelming to those lacking experience with informal education. Today, however, many informal learning institutions are collaborating with colleges and universities to introduce the use of informal science-rich sites to preservice teachers before they officially enter the teaching profession. As Professor Bob James at Texas A & M University, noted, "My students found informal science to be a new concept for them and were excited to observe...the participation of students" (personal communication).

Since it is so important for students to visit informal science education sites, district and school leaders must allocate financial support to provide opportunities for students to investigate this world outside the classroom (NRC 1996). Field experiences are a component of a well developed science program that enhances hands-on interaction and very often inquiry learning. An informal science exhibit or program can have many of the necessary components to enhance classroom learning.

Students being allowed to interact with and investigate natural phenomenon in a nature park, live animals in habitats, or hands-on investigations at a science center can apply classroom learning firsthand. Students do not leave education behind when they exit the classroom (Texas Education Agency 1999). Since learning is not confined to time behind classroom doors, the experiences provided at science-rich institutions strengthen the concept that learning is something that is done every day and in all situations.

A teacher who introduces students to informal science institutions can pave the way for them to be fully enriched with the resources offered. In fact, the use of informal science-rich sites as a part of K–12 science instruction is encouraged for implementation of the Texas Essential Knowledge and Skills. The Texas Essential Knowledge and Skills (TEKS) is the state-mandated curriculum framework establishing concepts that students, from elementary school through high school, should know and be able to do. Students who are encouraged to focus on the resources provided at an informal science-rich site during a field experience will be better behaved; able to spend quality time with the specimen, exhibit, or program; and better equipped to gain further knowledge from post-visit activities. Hein and Alexander (1998) noted that "students who have done work on a subject in preparation for their visit learn more from the experience...supporting the view that prior knowledge...is necessary for learning." Students must be trained to use the resources of an informal science-rich institution. As they are given opportunities to engage in learning in an informal learning institution, students will develop skills for future experiences at informal learning sites.

Most informal science institutions will provide information packets that enhance learning experiences for students. These guidelines are usually sent to the teachers in advance. The guidelines include institution policies; maps and diagrams of the facility; program curriculum; and pre- and post-visit activities for classroom use. Informal sites that do not offer information packets but have an interest in creating such packets for the future might consider using classroom teachers to help with development. Such a collaboration would create partnerships, solicit valuable information from the classroom teacher's perspective, and link exhibits and programs to current local, state, and national standards (Texas Statewide Systemic Initiative 1998).

Getting students to engage in observing and investigating in and out of the classroom is a rich experience. Imagine an elementary school in which students take field experiences to off-campus sites such as a museum, zoo, or nature park. These events occur frequently throughout the school year; content in the classroom is closely connected to the field experience; and financing the experiences is not an issue. The students' attitudes towards these activities reflect the teacher's attitude toward exploring off-campus sites. Observations and data collection are the focus since the students are using their time in the informal science institution to work cooperatively to explore and examine exhibits and specimens. Teachers can and will develop these experiences through careful collaboration with the numerous informal science education facilities that are available in Texas and around the country.

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6

Science Education in Boys & Girls Clubs

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For much of the 140-year history of the Boys & Girls Club Movement, leadership considered the schools the education experts. The role of the Boys & Girls Club (Boys Club at the time) was seen as providing informal guidance and character development. Our objective was to reach and work with those from the most challenging environments. The Club feared that an emphasis on formal education would prevent young people from participating in Club activities. In the late 1800s and early 1900s, as the wave of immigrants began to increase, issues of poverty, homelessness, street violence, and unemployment loomed. In an effort to reach the poorest "street kids" of the day, the Boys Club developed a unique environment to establish a safe haven. Clubs had full-time professional adult leaders available to talk with and pay attention to young people. Participants could come and go as they pleased and engage in the activities that interested them. Many "Club kids" were orphans who had run away from their orphanages or group homes and constantly feared being sent back. The Club provided a setting where they could play safely. Staff provided the opportunity to learn skills that could help them find work, and in many instances offered a much-needed hot meal for participants.

Time went by and Clubs became more widely established. Core program areas were defined. These evolved over the years, but typically there was an emphasis on activities and programs that attracted young people, such as athletics, game room activities, arts and crafts, science clubs, model rocket clubs, nature clubs, and camping clubs. The strategy continued to expose participants to a positive climate and caring adult professionals who sought to provide informal guidance. This attitude is reflected in the *Campbell Papers*, a series of papers designed to explain our philosophies and the way we approach working with children. The *Campbell Papers* are a valuable source of historical underpinnings of the Boys & Girls Club Movement. Educational programs that were fun were worked into the daily and weekly schedules of Clubs throughout the Movement. Staff often discussed school, grades, attendance, and homework with members. Spelling bees, geography bees, and quiz programs began to assume a role in the daily programs. Group clubs were established where members wrote and published in-house newspapers, helping them to improve their vocabulary by reading, writing, and telling stories.

A major shift began in the 1970s as funding for Boys & Girls Clubs changed. For the most part, the change emerged as local United Ways shifted their funding emphasis from funding entire organizations to funding programs and initiatives within these organizations. In an effort to maintain funding from the United Way, Clubs began to focus on issues such as drug abuse, teen pregnancy, education, gang prevention, and employment. They established relationships with the Department of Juvenile Justice to create programs that concentrated on educational advancement. Help-A-Kid (HAK) was one of the first formal attempts by the Boys & Girls Clubs national office to establish educational enhancement as a part of the daily Club experience for members. Small group clubs played a prominent role in providing educational opportunities.

The 1970s saw Clubs developing quiz programs, motivational reading programs, tutoring programs, and relationships with local school systems. Clubs wished to support what the schools were doing and offer additional education opportunities to kids. In the 1980s, Clubs continued to increase the amount of time and resources dedicated to educational programming. Science received a small amount of time and attention beyond locally developed small group Clubs. Clubs lacked the resources to develop science-based programs for young people, but had a growing interest in such endeavors.

The first program designed by Boys & Girls Clubs of America to specifically help young people develop an interest in the area of science was funded by the George Gund Foundation and was created in the early 1990s. This program, "The Ultimate Journey," was designed to introduce young people in small groups to environmental studies over a period of 10 weeks. The program was an immediate hit with Clubs across the country. The design of The Ultimate Journey is based on traditional program strategy. Members are introduced to the Club through Club-wide promotional activities. Each activity is designed to leave members with a "Wow!" Once interest in the subject has been determined, the group Club meets on a regular basis. The program appeals to the adult leaders and the clubs because it has been developed for use by a wide range of educators.

Boys & Girls Club staff are great youth workers, often products of the very communities they serve. Science is typically not a subject with which they feel very comfortable. The Ultimate Journey presents everything staff needs to conduct the program, complete with supplementary facts and presentation hints making activities fun and easy to lead. As weeks progress, participants are exposed to information necessary to develop a concern and interest for the outdoor environment where they live. The participants select a project to help improve, protect, or restore some element of their surrounding environment. Then they take a trip to an area such as a forest, park, lake, ocean, or mountain, where they actively engage in a restoration effort or other planned improvement event. Members have fun and learn at the same time. Possibly the most appealing aspect of this program is how it can be modified to take advantage of local resources and volunteers. Many Clubs now offer summer programs devoted to Ultimate Journey concepts, and many small groups spend their summers learning about plants, animals, gardens, and ecosystems where they live. This type of program can help young people recapture some of the joy and excitement of discovery and return to school with new ideas and enthusiasm for science learning.

Education has remained an important part of Club programming, and other initiatives are being developed each year to enhance academic performance and help young people make positive choices in their daily lives. National educational enhancement initiatives, such as geography and essay contests, have been developed and used in Clubs to encourage activities, programs, and events that support educational achievement. A number of partnerships have been established to help bring science education resources to Clubs. Boys & Girls Clubs work with 4-H, public television, Cornell University, the American Association for the Advancement of Science, and other organizations that have programs and resources that support the implementation of science education in the Club setting.

One such partnership is the collaboration of educators from Boys & Girls Clubs and the Miami University (Ohio). Faculty and students at the Miami University and the National Science Teachers Association had created a children's science magazine, "Dragonfly," that promoted science advancements discovered by children. The magazine provided a forum where kids could have their research featured and read what other kids were doing. To supplement this magazine, Boys & Girls Clubs of America and Miami University faculty collaborated to create a new program for kids. A Science Club was formed to teach children how to ask questions and conduct their own research to discover the answers. Local Clubs quickly accepted this new science program, "Dragonfly Quest."

Dragonfly Quest was embraced for several reasons. The materials are affordable and "user friendly." Staff and members are guided through an easy-to-understand process to answer questions formulated by group members. The supporting magazines are well written and enjoyable for staff and students alike. The Teacher's Companion helps staff better use the magazine. Club members are able to see the work of other young people and aspire to producing their own work for the magazine. Finally, each issue has a "Great Dragonfly Challenge," providing groups with clear questions to explore and answer. Working scientists are identified and are available to serve as mentors for new Boys & Girls Club Dragonfly Quest groups. This is a helpful resource for staff not comfortable leading self-directed groups. As young people develop their skills as young scientists, the support of a mentor can be a valuable asset towards scientific achievement.

We believe that young people who are excited by self-directed science programs will be more interested in science at school and will improve in all subjects. Our Field Service Directors work directly with local clubs and are able to track student progress over extended periods of time. In years past, a comprehensive survey was conducted every three or four years. It has since been determined that yearly studies are necessary to capture more focused information. Several surveys are now conducted every year. As reflected in these surveys and sales figures from our supply service, about 70–75 percent of our Clubs use The Ultimate Journey. Local Clubs are also creating educational programming unique to their neighborhoods. Research conducted by Dr. Schinke (2000) from Columbia University has demonstrated that educational enhancement activity in Boys & Girls Clubs has a profound impact on academic success among members from disadvantaged circumstances. The children were tracked in school for several years and a direct link was determined between the education enhancement activities in Clubs and improved performance in school. Schinke concludes, "Boys & Girls Clubs of America can rightfully take credit for helping youth in essential areas of academic achievement, school behavior, and study skills" (60).

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4-H—Science from Practical Education

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Cooperative extension is generally understood as the institutional system of nonformal education created by the Smith-Lever Act of 1914. The intent of the act was to formalize and cooperatively fund a university-based system of practical educators who would transfer useful research-based information generated or interpreted by land grant institutions to farmers, ranchers, and rural residents. Historically, the transferred information pertained to the needs of the rural public served by county extension agents and emphasized agricultural practice and agriculture-based business. The term cooperative refers to the unique partnership of federal, state, and county governments who fund the extension enterprise.

Contemporary cooperative extension efforts continue to support rural communities but provide a more varied education resource in response to the increased diversity of these communities. In many states, cooperative extension programs now also address interests of urban communities, building on strengths of the extension to provide support for such topics as urban forestry and gardening; community economic development; family nutrition and education; and youth leadership development.

Cooperative Extension Mission

In cooperation with our partners and customers, USDA Cooperative State Research, Education and Extension Service (CSREES) provides the focus to advance a global system of research, extension and higher education in the food and agricultural sciences and related environmental and human sciences to benefit people, communities, and the nation.

[Web page, www.reeusda.gov/1700/about/csreesa2.htm#mission]

The Smith-Lever Act guides 4-H youth development theory and its implementation. Cooperative extension programs are based on the theory that youth development is a process of mental, physical, and social growth during which young people prepare to live productive and satisfying lives within the customs and regulations of their society. The people who develop these programs and curricula for youth are in the business of providing educational opportunities through which youth can learn information and develop the skills that they need.

The four "H"s of 4-H stand for *Head, Heart, Hands,* and *Health*. These categories symbolize life skills necessary for youth to develop into capable adults. In a nutshell: *Head* represents thinking and managing; *Heart* represents relating and caring; *Hands* represents working and giving; *Health* represents being and living.

4-H youth programs take place in various settings: individual study, clubs, and school enrichment. Many program resources feature leadership and community service. Science programs engage youth in community- and home-based science inquiry and help youth apply science principles to local investigations and service. "Families Having Fun with Science Clubs" (California), "Project Feeder Watch" (New York), and "Satellite Spotting Contests" (New York), are a few examples of nonformal, family- or community-based science education programs sponsored by 4-H.

Today, traditional 4-H curricula themes are featured along with up-to-date themes on technology, space science, and ecosystems. For example, the 1999 4-H Cooperative Curriculum System catalog lists titles such as *Corn—Gifts of Gold, Gardening, Horticulture*, and *Animal Science Skills for Life*, because these topics meet the needs of many 4-H youth. But even these traditional subjects are presented in a new way: targeting life skills, emphasizing experiential-learning theory (Kolb 1984), and making the connection between science and the lives of youth.

Based on the numbers alone, 4-H provides an important opportunity to improve science literacy. According to 1998 enrollment figures, 6.5 million youth were enrolled in some kind of organized 4-H activity, from clubs and school enrichment to individual study and camp. Boys and girls are about equally represented, and more than 25 percent of participants are Hispanic, African American, American Indian, Asian, or Pacific Islander. Approximately 11 percent live on farms, while 24 percent live in central cities. Fifty-nine percent of participants are in grades four through nine. This past year, environmental education and earth science activities were selected by 1.3 million participants; activities focusing on plants and animals were chosen by 2.5 million children; and 1.5 million youngsters selected science and technology-based activities.

4-H Setting As Appropriate for Sciencing

In *The Joy of Sciencing*, Professor Richard Ponzio (1998) sets out a comprehensive explanation of the capacity of informal science education programs to add to the science education system. According to Ponzio, the case for science education reform is best articulated in the 1989 report of the American Association for the Advancement of Science, which states that the present science textbooks and methods of instruction, far from helping, often impede progress toward science literacy. These books emphasize the learning of answers more than the exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understandings in context, recitation over argument, reading in lieu of doing.

To meet the needs of science education reform, Ponzio recommends offering science education through an educational mosaic, including science learning opportunities available in the community. Efforts in schools can be complemented by parallel education efforts in after-school child care, youth groups sponsored by community agencies, programs offered by youth development clubs, and institutions such as zoos. Informal science also supports our dynamic and entrepreneurial economy, which can be fostered through real-world problem-solving. Again, Ponzio suggests that community-based education programs provide at least a partial answer, with opportunities to allow youth to try various problem-solving techniques and encourage multiple outcomes expressions of student understanding.

Cooperative extension and 4-H commitment to the role of families and communities in science education is demonstrated in part by the existence of CYFERNet. This is an Internet-based information system operated by the cooperative extension, linking a national network of land grant university faculty and county extension educators. The CYFERNet vision exemplifies the connection between education and family life. The mission of the National Network for Science and Technology (NNST), one of five networks that form CYFERNet, is to build capacity for improving literacy in science and technology through the support of creative and effective learning environments.

Informal learning environments, such as after-school child care, are an ideal setting for the kind of science education promoted by 4-H. Nancy Paulu and Margery Martin (1991) provide several tips for helping children learn science, emphasizing the importance of the home environment and family involvement. They indicate that because scientific knowledge is cumulative, the parent's role is crucial in encouraging a child's interest to begin learning early. Many elementary school children are taught little science at school and yet encounter learning opportunities in everyday life. A supportive family setting may lead to good science education because in it children have the freedom to ask all kinds of questions and may develop their own ideas and explanations without a fear of being wrong.

A successful community-based science education program must be fun, interesting, and inexpensive. Leaders and youth participants have the right to vote with their feet in terms of participation. Professor Richard Ponzio enumerates five unique aspects of community-based education settings that enable these programs to enhance science literacy development. Those aspects are: a) being sensitive to the time demands of their targeted clientele; b) being sensitive to the interests and ability levels of the intended audience; c) being designed around experiential activities targeted to the various age levels of the participants; d) having built-in opportunities for young people to learn science from each other; and e) and allowing for variable authentic outcome.

Research As a Foundation for 4-H Science Education Resources

A University of California 4-H curriculum, SERIES (Science Experiences and Resources for Informal Education Settings), is an example of a curriculum based on the theory that science education can be part of the youth experience in community-based settings. SERIES includes titles such as *Chemicals Are Us*; *Beyond Duck, Cover, and Hold* (earthquake education); *It Came from Planted Earth*; *Oak Woodland Wildlife*; *What's Bugging You?*; *Recycle/Reuse*; *Sciencing with Snails*; and *From Ridges to Rivers: Watershed Explorations*. SERIES materials strive to incorporate current theories of pedagogy and are aligned with the *National Science Education Standards* (NRC 1996).

Research foundations for 4-H curriculum and program development are numerous. In brief, curriculum guidelines are modeled after the recommendations of Project Synthesis (NSF 1978) synthesizing and interpreting more than 2,000 pages of information from three NSF studies and National Assessment of Educational Progress (NAEP) reports. Recommendations for effective youth-centered curriculum include organizing content along an experiential path, facilitating experience from an experiential perspective, and providing opportunities for post-unit assessment.

To facilitate this effort, Horton and Hutchinson (Kolb 1984) provide a research base for making decisions about the following aspects of curriculum development: a) identifying content; b) selecting the level of experience; c) relating elements of experience, activities for learning, and science skill development; and d) facilitating experience from a nonformal perspective. Nurturing scientific literacy provides nonformal educators with a checklist that they can apply while developing new curricula. The checklist addresses content, experiential quality, skill development, activities, and assessment. The theory behind the Give Water a Hand *Action Guide* (Cairn et al. 1996) fosters service learning attitudes and may also be applied. Give Water a Hand is a national watershed education program designed to involve young people in local environmental service projects. [For more information about the program and to download program materials, visit the Give Water a Hand Web site at *www.uwex.edu/erc/gwah/*.]

The application of research-based information to 4-H curricula has been guaranteed through a national peer review process based on national criteria. Such national guidelines provide extensive details to ensure that the curriculum promotes experiential-learning methodology, highlights the learner, clearly states objectives and evaluation procedures, and is properly presented to the target audience.

Over 120 curricula have been peer-reviewed and recommended to the national collection. Of these, more than half address science education topics, including aerospace, animal science, biological science, earth cycles, energy, engines, environmental stewardship, food science , forests, health, nutrition, physical science, rangeland, science and technology, technology and engineering, wildlife, and waste management.

Research Supporting Work with Targeted Audiences

Reaching targeted audiences is a hallmark of cooperative extension education efforts. Community-based education requires application of social marketing methodologies which feature understanding and connecting to audiences targeted for technological innovations or changes in applied practices. Key features include:

1. **Describing an ideal practice or behavior by evaluating the**
    - impact on the problem
    - observable consequences of the behavior
    - similarity to actual practices
    - simplicity
    - cost
2. **Providing an educational strategy for each behavior that**
    - asks for a commitment
    - provides a specific prompt
    - communicates the norm
    - removes barriers

One of the most well studied audiences for 4-H science education is the teens involved as science educators in a school-aged child care science program, Youth Experiences in Science (YES). Using content analysis of session videotapes and teen instructor portfolios and interviews with children a week after the experience, Ponzio and Peterson (1999) were able to determine information about teen effectiveness and training needs. Teens were seen as effective educators because they relate well with children, are likely to appreciate the activities, and react with positive certainty and fidelity.

There are other efforts to study appropriate education methodologies for various groups served through extension programs, such as Latino youth, youth at risk, or underserved youth. A good source for locating this research is through the Internet Web-based publication, *Journal of Extension* at *www.joe.org*. From practical agricultural information to today's computerized communications, 4-H has been a steady provider of science education.

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HOSO: Play, Practice, Parents, and Time

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Why not after-school science in local classes just like dance, karate, piano, or soccer practice? Perhaps today that question does not even make sense. But over two decades ago, before *Educating America for the 21st Century* (National Science Board Commission 1983), before *Science For All Americans* (Rutherford and Ahlgren 1990), before the *National Science Education Standards* (NRC 1996), the concept of local, regular, accessible, "recreational" science programs was different. There had been science clubs for many years for a few students who were already motivated to experiment and invent, but for most children with a less developed focus, from preschool through the elementary school years, there was little. In addition, there has been an increasing focus on after-school time, both for children's continued learning and safety (Bergstrom 1984; Chung 2000; National Park and Recreation Association 1994; the National Community Education Association et al. 1999). Learning more about the world through science activities with caring adults is a useful, pleasurable way to spend secure after-school time.

What is now HOSO (Hands On Science Outreach) began as a community school program in 1980 to offer children more time to play and practice science. The community school movement had developed as a way to use publicly funded school buildings for neighborhood activities during nonschool hours. I had been a classroom teacher and had returned to school to study science. During a sabbatical year in Toronto, near the Ontario Science Centre, I had gained a new appreciation for informal science and so designed the first versions of what was to become the Montgomery County, Maryland, Hands On Science program for the local community school. In a short while, the program was incorporated into the county Parent Teachers Association's non-profit after-school organization and was growing wildly as eager parents and children signed up for this opportunity. A Hands On Science program team was formed to sustain the ongoing effort. We trained many parents (as well as teachers and other community members) to lead the small groups of children. We provided activity guides and kits of complete materials. Science enrichment became convenient, feasible, and fun. Small fees covered our costs. PTA support, grants, donations, and internal budgeting made it possible for families in need to participate.

When families moved beyond Montgomery County's borders and asked to take the program with them, Hands On Science Outreach (HOSO) was born. The National Science Foundation funded the next stage of growth in piloting and seeding HOSO in diverse communities. As I write this, we continue in our 21st year. That is the brief history of how the idea became a sustainable program.

The teaching and learning foundations for the content were grounded in theory and experience. Nonschool science for young children has to be fun. They and their parents have to choose it. There is time and place enough to learn the discipline of serious science research, but here, at this level, we want to engage children, to entice them to enjoy the playfulness of their minds. The link between play and science is curiosity and problem solving; and the link between play and science as a human endeavor lies within the adaptive drive to explore, predict, and control the environment for human success. Biologist Edward O. Wilson (1975) wrote that play, "serves an important role in the socialization of mammals. Furthermore, the more intelligent and social the species, the more elaborate the play." He concurs with other biologists that play is a way to explore and test potential patterns of behavior for their goodness of fit.

Sir Isaac Newton, whose work guides most of the physical science taught in precollege science classes, talked about his own research in these terms (in Westfall 1980):

> I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me. (863)

Diane Ackerman (1999) wrote more recently of play that it is

> …an activity enjoyed for its own sake. It is our brain's favorite way of learning and maneuvering. Because we think of play as the opposite of seriousness, we don't notice that it governs most of society—political games, in-law games, money games, love games, advertising games, to list only a few spheres where gamesmanship is rampant. Play may have different strengths, not all of them mystical and soul-stealing. But even in its least intoxicating forms, play feels satisfying, absorbing, and has rules and a life of its own, while offering rare challenges. It gives us the opportunity to perfect ourselves.

> It's organic to who and what we are, a process as instinctive as breathing. Much of human life unfolds as play. (11)

Setting aside convenient time for science play determined the implementation structure of HOSO.

Another guiding principle for HOSO is that all the children should do each of the activities. These activities are created or chosen with the assumption that the hand and mind are largely inseparable in the experience that sets down what is called "prior knowledge"—the single most powerful learning factor that Dewey explained eloquently for educators in the early 20th century (1997/1938). Theoretical support also comes for this principle from anthropology and evolutionary biology as well as education. In *The Ascent Of Man*, Jacob Bronowski 1973) wrote of the artifacts found among fossil remains of ancient people that they provide evidence for people who can anticipate a future. Richard Alexander (1990), a zoologist, studied speciation and concluded that within a highly social animal, the human brain adapted to a consciousness that implies "the ability to use information from the social past to anticipate and alter the social future, to build scenarios—to plan, to think ahead, and to anticipate different possible outcomes and retain the potential to act in several alternative ways, depending on circumstances that can only be imperfectly represented at the time the plans or scenarios are being made." It is interesting to note that he believed that language developed to enable us to communicate "events displaced in space or time or both." So, we look at science as a way to explore, experiment, talk about, and plan for what might be best for ourselves, now and in the future.

Our growth patterns support lots of learning. Let us consider ourselves as a species. We are an *altricial* species. That means that we are not ready to fend for ourselves when we are born, as compared to a *precocial* species (for example, ducks), which can waddle and feed early on. Our altriciality is the most extensive of all animals. We are completely helpless at birth. We remain with our parents and siblings for many years, perhaps never truly separating. Why? To learn. To survive, our large, adapted brain requires that we provide it (and that it neurologically develops) with enough complexity to make our own choices to go out and form our own family units and provide for them. That is how we are programmed by our biology. A long and successful learning period, complete with extensive socialization and language, is one of the critical traits that make us, as humans, distinctive.

Learning was a family affair for most of human history. Large group education is a response to changes in our social patterns (Goldberg 1970). Educating groups of children became necessary when their parents went away from the home to work. At the very least, schools fulfill two basic needs: Children are supervised and children are taught. Parents, in turn, require that they know how well these needs are accomplished. Accountability grows out of this relationship. It would not make sense to turn over such an essential part of our means to survive without asking if the job done in our place were a good one. While this accountability (testing of one sort or another) is essential to our schools, what is it to the learner? A test created by a teacher or other authority evaluates what that authority thinks is important. For the learner, however, passing or doing well on a test is an accomplishment to meet external standards—those standards set by someone else. Formal schooling teaches us for and about the essential standards of our society. The *National Science Education Standards* propose the goals for school science. These *Standards* recognize the role that informal resources take, but do not address the explicit differences in the learning settings or styles (Katz and McGinnis 1999).

Informal education on the other hand, usually allows us to learn to our own satisfaction. Being able to set our own standards, setting up or approaching the problems that come to us in a less structured way, and working our way through solutions that satisfy us, are all important to our nonschool lives. Think about the numbers. We spend about six hours a day, nine months a year, for 13 to 17 years of our lives in formal schooling. Another 50 years or so (and all the other hours of our in-school years) are spent outside of a formal school setting.

The mind, then, is meant to be continually active, learning in and out of purposeful schooling. What of the handwork in the mind/hand construction of HOSO? Galileo (1564–1642) is credited with being the first "hands-on" scientist in recorded history—a person who sought evidence through experiments. However, Bronowski (1973) again reminded us that experimentation and pleasure through hand and mind are a part of our nature:

> I have described the hand when it uses a tool as an instrument of discovery.... We see this every time a child learns to couple hand and tool together—to lace its shoes, to thread a needle, to fly a kite or to play a penny whistle. With the practical action there goes another, namely finding pleasure in the action for its own sake—in the skill that one perfects, and perfects by being pleased with it. This at bottom is responsible for every work of art, and science too: our poetic delight in what human beings do because they can do it. The most exciting thing about that is that the poetic use in the end has the truly profound results. Even in prehistory man already made tools that have an edge finer than they need have. The finer edge in its turn gave the tool a finer use, a practical refinement and extension to processes for which the tool had not been designed. (116)

Engaging our hands leads to engaging our minds. We may infer from fossil evidence that the use of the hand and the use of the mind developed in tandem and that they were fed by the "enabling mechanism" (as biologists put it) of pleasure.

Traditionally, children have been offered sports, music enrichment, and handcrafts as after-school activities. These are generally viewed as "play" without a determined connection to the active processes of "problem-solving." But the opportunity for science is ever present. Is that ball coming in high or low? Can I run faster than those two girls coming my way? Will these two notes be harmonious? Will this glue hold these two things together? Without analyzing the process, children are playing through or building the scenarios (through game plans) that enable them to get where they want to go. HOSO was created to give children some nonschool (personally evaluated) time to see that there are sciencing opportunities in just about everything that they do. The first level of approach is *recreational*. The activities should give the children pleasure. They should have a high fun value under the heading of science. They are centered around inquiry. The activity guides are designed as a series of questions that help children construct their own knowledge.

With these foundations for HOSO's goals and operations, what does research tell us about what has happened? The Goodman Research Group did an NSF-funded evaluation of HOSO (Goodman 1993). Using surveys, visuals, questionnaires, interviews, and observations, they looked at both enrolled children and a comparison set of children in urban and suburban areas in four locations in the United States. The children in HOSO programming made significant gains in their understanding of science, their content knowledge, and their perceptions of scientific activity and who can do science. There was no difference by gender or ethnicity. The comparison groups did not make the same gains. Both children and adults enjoyed the experience. Analysis concluded that the children's experience was influenced by the adult leader's attitude and comfort with teaching. The findings cautioned that they could not predict long-term impact. While it is not impossible, it is often difficult to assess long-term impact for specific informal education experiences. Are those who sign their children up creating a cultural/intellectual environment for their children in general, of which these individual program choices are only a small part? There is evidence to suggest that this is so (Tamir 1991). This should not discount, of course, that such experiences do add up to encouragement over time.

NASA-Goddard volunteers used HOSO programming as part of their own community outreach efforts. With the template, "Profiling Student Programs," developed by the National Center for Improving Science Education, the results described the intended and actual practices to be in unison (SDS & Associates 1994).

The Bonneville Power Administration used HOSO's summer programming to offer free summer science camps to low-income Hispanic children in Portland, Oregon. Their qualitative evidence spoke to children who felt empowered to engage in science for the first time (Dragoon, Owen, and Ruff 1992).

My own research has been on the adult leaders (HOSO's name for those who meet with the children's groups). I have found that HOSO provides an opportunity for adult education in science and teaching. The mothers with whom I worked sought these experiences to be more involved with their children, to offer science enrichment to other children in their communities, and to gain teaching skills (Katz 1997). Sometimes they used HOSO as a testing ground for a career change. The most challenging problem in implementing the HOSO programs is attracting and retaining sufficient Adult Leaders to meet the demand for program classes. I found that time constraints (managing after-school time for their own children, for example), wanting to make more money, and behavior management issues were reasons cited for not continuing to lead classes (Katz 1998). These are important issues for those of us concerned with quality after-school programming.

HOSO continually monitors its programming through questionnaires, verbal feedback, and participation data analysis. We use this information to keep the program lively, adapt it to new locations, and to reach as many children as we can. There are now many places in the United States and a few abroad (thanks mostly to the Internet) that have made HOSO after- school science a routine option in their communities providing a time and place for both children and adults to play and practice science skills and concepts.

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The Educator's Species

Connecting Conservation and Science Education at Accredited Aquariums and Zoos

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The thought of visiting an accredited zoo or aquarium evokes images of exotic animals and hometown family outings for hundreds of millions of people. A relatively small but growing group of educators recognizes and appreciates both the deep commitment of accredited aquariums and zoos to science literacy and their full potential as educational partners for science teachers. Zoos and aquariums extend learning beyond the classroom to a whole community/whole life process. Samples of successful educational partnerships will be presented.

The Educator's Species and the American Zoo and Aquarium Association

The brightest lights shine on the animals. Visitors clamor to question carnivore curators, dolphin trainers, reptile keepers, and all animal caretakers. Visitors ask, "Which species is yours?" Ironically, it is the educator's species, *Homo sapiens*, that will ultimately differentiate between survival and extinction for most endangered species. Zoo and aquarium visitors may not all choose careers in science, but they will have the right to vote and the opportunity to reproduce. They will buy products, need space, and want clean air and water. Ultimately, they will make their choices and teach their children based on what they know and believe, with or without us. Accredited aquariums and zoos are committed to science education because improved science literacy is essential to conservation.

All 181 institutions of the American Zoo and Aquarium Association (AZA) share a strong commitment to education. Together they reach more than 12 million people

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annually through the efforts of over 800 staff educators and 12,000 volunteers. School programs host over nine million student visits (3.6 million free of charge) and training workshops for over 85,000 teachers annually. Alignment with school curricula and science standards is now the rule rather than the exception for museum education. Museums align content with local, state and/or federal curriculum standards for 92 percent of math programs, 87 percent of science programs, and over 97 percent each for in-service training programs, resource kits, and pre- and post-lessons [Institute of Museum and Library Services (IMLS) 1998]. As an added resource, aquarium and zoo programs carry conservation messages to virtually every community group imaginable. Nine million people annually use programs for families, seniors, scouts, preschoolers, and countless others.

Schools and Museums: Complementary Learning Environments

Museums in general and accredited zoos and aquariums in particular are near-perfect venues for effective science education and credible partners for science educators (Falk and Dierking 1992). Community esteem is built by providing safe, convenient, and accessible places for families, by holding and exhibiting collections that are innately fascinating, and by focusing educational efforts on issues that are critical to the welfare of humans. Science guides daily operations as collection managers, keepers, veterinarians, and researchers pursue their commitment to conservation and the welfare of the individuals and populations in their care. Field conservation programs offer the science and relevance of *in situ* conservation to North American schools.

Guests arrive concerned about animals and ready to learn. The public feels strongly about the treatment of animals in aquariums and zoos (69 percent) and believes that these institutions can contribute effectively to preserve species (57 percent regard this function as "essential"), to rehabilitate injured/homeless animals (56 percent) and to educate about both environmental conservation (51 percent) and the animals displayed (49 percent; Roper Starch Worldwide 1995). Finally, zoos and aquariums are recognized and trusted messengers about the environment and conservation. A recent poll ranked zoos and aquariums third as a trusted source of messages about ocean protection (Seaweb 1996).

An Additional Distinction—The Importance of Accreditation

The terms "aquarium" and "zoo" are used broadly in the world today. What do they mean? In 1999, over 2,300 organizations held Wildlife Exhibit Permits from the Animal/Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture, a minimum legal standard to exhibit wildlife to the public. The 181 institutional members of the American Zoo and Aquarium Association (AZA) voluntarily adhere to much higher standards of zoo and aquarium operation. AZA institutions represent fewer than eight percent of U.S. federal permit holders, but AZA membership represents an ethical standard and a rigorous accreditation process as well as a professional affiliation.

- AZA institutions adhere to the AZA Code of Ethics (AZA 1999).
- AZA institutions must meet elevated standards of operation through a formal accreditation process. Accreditation requires documentation of substantive activity in conservation, education, research, and recreation. A site visit goes well beyond confirming high standards of animal care and management. The visiting team examines virtually every aspect of operation (revenue sources, governance, adequate staffing for education, etc.). Accreditation lapses after five years, and each institution repeats the entire process to ensure that it keeps pace with best practices.
- AZA also claims 6,000 individual members who develop and improve professional standards through an extensive committee structure. The AZA Conservation Education Committees (CEC)'s current three-year strategic plan sets major objectives, including trends assessment, educational technology, evaluation, and promoting educational partnerships (AZA 1998).

Can Aquariums and Zoos Help?

A sample of recent research supports Falk's premise that "museum learning experiences facilitate some degree of learning in all participants and significant learning in the majority of visitors" (Falk 1999).

- A study of the National Zoo's *Think Tank* exhibit demonstrated lasting impact on visitors' knowledge and attitudes about animal thinking and behavior (Bielick and Karnes 1998).

- A study by five museums in the Philadelphia-Camden area confirmed family learning and documented a relationship between learning levels and specific, observable behaviors (Borun et al. 1998).
- A training program for pre-service and in-service elementary teachers at the Oregon Zoo produced statistically significant gains in teachers' comfort with teaching science, knowledge of science methods, knowledge about animals and conservation, and attitudes about teaching science. These gains persisted six months later (Sheng et al. 1995).
- Aquarium and zoo programs communicate science content and foster caring attitudes about animals and nature (Kreger and Mench 1995). Responsible expertise is essential to ensure animal welfare and to avoid communicating mixed or hidden messages. As daily managers of living collections, AZA professionals represent the best source of animal experiences that are accurate and educational while maintaining due regard for the highest existing standards for animal management and care.

Two caveats attach. First, educational research, evaluation, and peer-reviewed publication from zoos and aquariums are still not routine. Most evaluations measure visitor satisfaction and are conducted for internal use. AZA recognizes this deficiency and has made evaluation a principal objective of the current strategic plan of its Conservation Education Committee (AZA 1998). Evaluation also begs for effective collaborative efforts between formal and informal educators. Second, the complexity and choice available to museum visitors plus the diversity of a visitor's prior experience and knowledge level distinguish museum environments from formal learning opportunities. This distinctness suggests the need to recognize special learning objectives, methods, and assessments (Falk 1999).

Models of Partnership Excellence

Indications of success by AZA aquarium/zoo-school partnerships are encouraging:

- The National Science Foundation's website lists 54 education grants to over 20 AZA member zoos and aquariums since 1989. Exhibit development and teacher enhancement predominate, but the variety of other awards illustrate the breadth of zoo and aquarium education.
- All AZA institutions work with school partners, but 10 aquariums or zoos collaborate with a local school district in operation of a dedicated "zoo school." Each partnership provides intensive and extended access to the zoo or aquarium while teaching a balanced and complete curriculum. Two AZA "Zoo Schools" won national recognition in 1999. The School of Environmental Studies at the Minnesota Zoo was selected as a New American High School by the U.S. Department of Education and the National Association of

Secondary School Principals. The Lincoln Public Schools' "Zoo School" at Folsom Children's Zoo gained recognition when the school's team of four teachers was selected for *USA Today*'s 1999 All-USA Academic Teacher Team.

- All AZA institutions have broad impact on their local communities. Two AZA institutions have been recognized with the National Award for Museum Service by the Institute of Museum and Library Service—the only national recognition of a museum's public service role. The National Aquarium in Baltimore was honored for excellence in community partnerships, outreach programs, and special programs for underserved audiences, including at-risk, high-ability, and low-income residents. The Lincoln Park Zoo was chosen for intern programs for underserved high school students, an after-school program that teaches nutrition education to inner-city youth alongside lessons about zoo nutrition, and a three-year teacher development program.
- Extensive collaborations including AZA zoos and aquariums have developed in Chicago (Chicago Wilderness, Chicago Region Diversity Council 1997) and Philadelphia (Philadelphia-Camden Informal Science Education Collaborative, Borun et al. 1998). These collaborations have broad and inclusive agendas for community benefit.

The educational benefits of accredited zoos and aquariums offer exciting, relevant, science-based connections between global conservation and local human interests and actions. Dramatic growth of aquarium/school and zoo/school partnerships will serve the science literacy and public education objectives of all educators.

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The Use of Research and Evaluation in Science Museums and Science Centers

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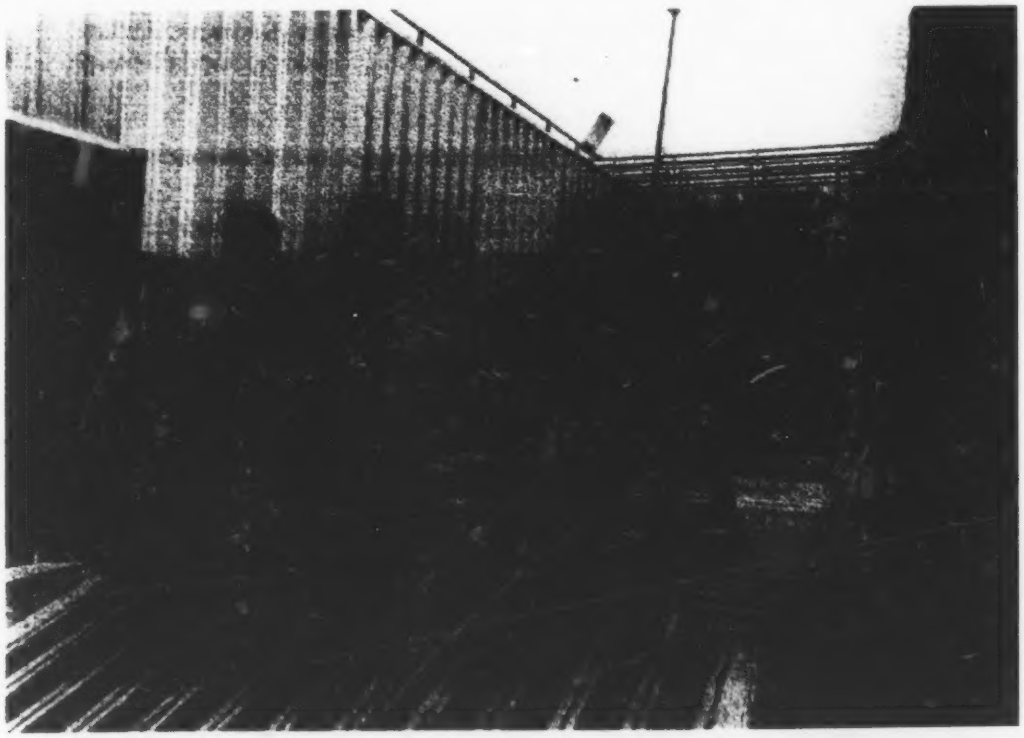
Science-technology centers are the fastest-growing cultural institutions in the country. In 1987, an estimated 40 million annual visitors attended science-technology centers; in 1998, the number quadrupled to 116 million. Today the number is closer to 120 million. The majority of science-technology center visitors are families on weekends and holidays and school groups (mainly elementary and middle level) when school is in session.

This growth in attendance coincides with the science education reform movement spearheaded in the early 1980s when the Carnegie Commission's report, *A Nation At Risk: Educating Americans for the 21st Century*, alerted the public to the dismal state of science understanding and teaching. Over the next two decades, three major projects influenced American science education: (1) the Systemic Science Reform Programs of the National Science Foundation (NSF); (2) *National Science Education Standards* produced by the National Research Council; and (3) *Project 2061*, a broad-based science curriculum sponsored by the American Association for the Advancement of Science. These three initiatives, coupled with the growing use of technology in the classrooms and homes of America, set a new climate for science education, and in the process, changed the perception and use of hands-on science centers. No longer seen as separate, discretionary, and supplementary institutions, they became equal partners with schools in science teaching and learning.

In 1993, the New York Hall of Science (NYHOS) hosted an NSF-sponsored conference, Future Directions: A Dialogue Between the Formal and Informal Science Education Communities. As the science reform movement gained momentum, the formal and informal science education sectors joined forces. Science-technology centers turned to the schools to learn about mandated curriculum and standards, and schools turned to science centers to help train teachers in the new, inquiry-based approach to science pedagogy; collaborations between schools and science centers began to mushroom.

The mission of almost all science-technology centers is to deliver science concepts through interactive, hands-on exhibitions and programs to a broad audience to increase public understanding and appreciation of science. Exhibitions and programs offered by science centers have expanded and become more refined to reach and serve different audiences. Research plays a major role in the development and implementation of these programs. Four major audiences have been the focus of program development and related research: general audiences, families, youth, and schools through teacher training.

The distinction between research and evaluation is important; science-technology centers rely on both methods for program development and assessment. Research is focused on broad questions: It uses formal standards, large samples, detailed statistical analysis, and small margins of error; it tends to be quantitative. Evaluation tends to be project- and site-specific, uses smaller samples, and is generally more qualitative. Science-technology centers use both methodologies; evaluation is the more common



approach since science centers develop their exhibitions and programs for specific audiences.

The following examples provide a framework for the way research and evaluation are used to develop and implement exhibitions and programs at science centers.

General Audiences

Unlike collection-based museums, science-technology centers develop their own exhibitions and programs on various science topics. Front-end evaluation is used to assess visitor knowledge and interest in science topics for exhibition and program development. Front-end evaluation techniques include: (a) focus groups, (b) one-on-one interviews, and (c) written questionnaires. At the NYHOS, a front-end evaluation for a microbiology exhibition indicated that visitors understood that microbes were alive and in our bodies and made people ill, but had little to no understanding of their role in the earth's ecology, their ubiquity, or their beneficial effects. Visitors were extremely interested in the AIDS virus and the common cold. These findings were used to develop the exhibition, Hidden Kingdoms: The World of Microbes.

Formative evaluation is a technique used to refine exhibits and programs in the development stage. The analysis of visitor responses to exhibit and label mock-ups helps determine accessibility, understanding, concept formation, and interest. Exhibit elements are refined accordingly before final versions are fabricated. Formative evaluation of an outdoor exhibition, Science City, by the NYHOS indicated that label copy needed to be placed next to eyeholes on several exhibit modules. The copy was moved before final fabrication.

Summative evaluation is used when an exhibition is complete, installed, and in use by the public. This type of evaluation generates findings about the exhibition both for in-house staff and for the field. Basic principles of exhibition design and content-specific findings form the basis for future exhibit development.

Families—Intergenerational Learning

Most nonschool visits are made in intergenerational family groups. Science-technology centers are popular with family groups as evidenced by attendance, holding power, and observable enthusiasm. The goal of all science and technology exhibitions and programs is to help visitors of all ages learn science concepts in an intergenerational setting. While it is relatively easy to determine visitor interest and involvement, determining what learning has taken place is more complex. A seminal study, *Family Learning in Museums*, done by the Philadelphia-Camden Informal Science Education Perspective (Dristas et. al. 1998), developed new methods of observing families, identified three hierarchical learning levels, and produced research findings indicating that families do indeed learn science in science-technology museums. This study set new guidelines for understanding family learning.

Youth—Involving Underrepresented Youth with Science

In 1986 the NYHOS reopened to the public with an Explainer program, based on a smaller program at the Lawrence Hall of Science; mostly minority youth recruited from area community colleges were hired and trained to work as floor staff, interpreting exhibits to the public. The NYHOS Career Ladder was developed to provide minority youth with access to science and science-teaching careers through employment at a science-technology center. In 1991, the Youth Achievement Through Learning, Involvement, Volunteering, and Employment (YouthALIVE!) initiative of the De-Witt Wallace-Reader's Digest Fund was initiated and administered through the Association of Science-Technology Centers. Its goals were similar to the NYHOS Career Ladder.

Typical of the field, evaluation has informed the development and replication of these programs at all phases of development. The NYHOS Career Ladder was evaluated twice—once in 1991 by Inverness Research Associates (St. John and Heenan 1997), and again in 1995 by Holland Research Associates. The first evaluation determined the positive quality of the experience for participants; the second, a longitudinal study, assessed impact by analyzing career and employment situations of Career Ladder alumni (34 percent had become teachers). These findings proved that employment of minority, underrepresented youth in science-technology centers positively impacted their attitudes towards science, towards themselves as science-able, and towards career choices in science and science teaching.

YouthALIVE!, developed in two phases, has been implemented at 72 science and children's museums nationally. The program has undergone extensive formative evaluation; findings from Phase I formed the basis for program planning and funding requirements for Phase II. Ongoing studies of individual programs resulted in an analysis of infrastructure elements essential to program success that now provide a baseline for successful youth programs in science-technology centers and children's museums.

Teachers and the Schools

Science-technology centers have become major partners in science education through teacher-training programs in the use of technology and inquiry-based learning. All state, federal, and private foundation grants require a research component designed to assess achievement of stated project goals. The use of "outside" evaluators, professional researchers, is typical for the field. Outside evaluators are often included in project development meetings; they provide ongoing feedback (formative evaluation) as projects unfold; and their input may significantly affect final project design.

School and museum staff collaborate to develop goals so that training is directed towards local and national standards, mandated curriculum goals, and perceived school needs. Many science-technology centers tailor their teacher training to local district needs and involve teachers in training design and delivery (e.g. EcoTarium in Worcester, Mass.). Assessment of teacher-training programs is set within this framework. Typical examples are the training of classroom teachers through workshops, institutes, and in-classroom support, in the use of inquiry-based techniques and classroom technology use.

The NYHOS offers a series of teacher training/rental programs involving the classroom technologies, including: (a) STARLAB, an astronomy program delivered through the use of STARLAB, a portable planetarium system; (b) microbiology through the rental of microscopes, video microscopes, and culturing equipment; and (c) technologies through the rental of laptop computers. In each case teachers receive both training at the museum and the rental of technologies for classroom use. Evaluation techniques used to assess these programs include: (a) tracking number of rentals, (b) classroom observation by museum staff, (c) oral and written feedback from teachers, (d) feedback from school administrators, and (e) analysis of recidivism and reenrollment by individuals and school districts.

Resources

WEB sites

The following organizations maintain and frequently upgrade Web sites, providing access to publications, cutting-edge issues, and links to other informal science education organizations.

American Association for the Advancement of Science
1200 New York Avenue, NW
Washington, DC 20005
202-326-6670
www.aaas.org

American Association of Museums
1575 Eye Street, NW
Suite #400
Washington, DC 20005-1105
202-289-1818
www.aam-us.org

Association of Science-Technology Centers
1025 Vermont Avenue, NW
Suite #500
Washington, DC 20005
202-783-7200
www.astc.org

Center for Museum Studies
Arts and Industries Building
Room 2235
Smithsonian Institution
Washington, DC 20560-2729
202-357-3101
www.si.edu/organiza/offices/musstud/

Institute of Museum and Library Services
Office of Museum Services (Museum Programs)
1100 Pennsylvania Avenue, NW
Room 609
Washington, DC 20506
202-606-8539
www.imls.gov/utility/contact.htm

Museum Learning Collaborative
Learning Research and Development Center
University of Pittsburgh
3939 O'Hara Street
Pittsburgh, PA 15260
412-624-7020
mlc.lrdc.pitt.edu/mlc

National Science Foundation
4201 Wilson Boulevard
Arlington, VA 22230
703-306-1234
www.nsf.gov

Visitor Studies Association
Department of Psychology
Colorado State University
Fort Collins, CO 80523-1876
970-491-4352
http://museum.cl.msu.edu/VSA/

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11

Ecology Foundations: Environmental Education in the Field

Celeste Prussia
Missouri Botanical Garden

The Litzsinger Road Ecology Center (LREC) is a program within the Education Division of the Missouri Botanical Garden. While the Garden has always been dedicated to educating young people about plants, the mission has expanded to provide science and environmental education throughout the St. Louis community and beyond. Staff members support the education division goals as they work to improve science education in schools; teach ecology and environmental science to children; train teachers to understand ecology better and teach more environmental science; and develop instructional materials and resources for teaching about ecology and the environment. In the broadest sense, the Garden educational programs seek to change the ecological practices and attitudes of children and adults (Missouri Botanical Garden 1994).

The LREC is a 34-acre ecology study area within a 20-minute bus ride from most St. Louis area schools. It encompasses various habitats, including bottomland forest, restored prairie, and an urban creek. The LREC was established as an educational and field research facility and is closed to the public. Teachers may schedule to return with their students for field study after participating in ecology-based professional development on-site or at the Garden. One goal of the program is to prepare children for science education by providing high-quality, hands-on, experiential learning in ecology and environmental education. Field studies at the site promote an understanding of the processes of science, the development of lifelong analytical and methodological skills, and greater understanding of ecology and natural systems.

What Research Supports Our Setting As One Appropriate to Science Education?

The nature study movement in schools was first defined in Wilbur Jackman's Nature Study for the Common Schools (1891) following a mid-1800s incitement by Louis Agassiz that his students should study nature, not books (Hungerford et al. 1980). During the 1920s, the highly regarded leader of outdoor education, L. B. Sharp, stated: "Teach outdoors what is best taught outdoors, and indoors what is most appropriate there" (Roth 1978, 18). Swan (1975) describes nature study as the precursor of science education and its current status as one of its key elements:

> Much of the focus on nature education...was on learning through direct and/or first-hand observation, using experiences in and outside the classroom. Detailed inquiry and discovery approaches to learning, so highly touted by present-day educational theorists were set forth by Jackman shortly before the turn of the century.

Education outdoors holds the potential to serve all subjects: science, math, language and fine arts, social studies and physical education. That the outdoors has historically been and continues to be used in this manner speaks volumes for the natural world as a learning laboratory for students.

Building ecological foundations by learners is the first step in the ladder of goals for curriculum development in environmental education (Hungerford et al. 1980). Engagement in activities that examine natural systems promotes student development toward the first three components of environmental education: awareness, knowledge, and skills. The conceptual scheme of ecological foundations employed at the LREC follows that described by Disinger (1993) after Ballard and Pandya (1990). The framework they described spans natural and social sciences and the humanities. The curriculum content includes the following components:

- natural systems
- environment, Earth, biosphere
- abiotic components (water, air, soil)
- biotic components (plant, animal)
- processes (weather and climate, biogeochemical cycles, evolution, and extinction)
- biological systems (ecosystems, food chains and webs, community, population, habitat, and niche)

At this level, students at the LREC investigate interactions and interdependence of individuals and populations in a community or ecosystem; environmental influences and limiting factors; energy flow and nutrient cycles; succession of plants and animals; and human interactions with and impacts on ecosystems. As students make and record their observations of plants and animals, collect data on abiotic factors at study sites, and pose questions that demonstrate their synthesis of prior and current experiences with nature, they are fulfilling goals set forth in the *National Science Education Standards* (NRC 1996).

The final two components of environmental education—attitudes and participation—are not a current focus of the learning activities for school-year visits by students to the LREC. Attitudes and participation relate most closely to the three higher-level goals of environmental education that build on the ecological foundations. At the higher-level goals, students: conceptualize how values and actions impact issues; investigate environmental issues and evaluate alternative solutions; and make decisions, which apply and evaluate actions taken toward the dynamic equilibrium between the quality of life and the quality of the environment (Hungerford et al. 1980). A high school service-learning program operating in the summer at the LREC, the Ecological Restoration Corps, is incorporating education toward the three higher-level goals. The Investigating and Evaluating Environmental Issues and Actions: Skill Development Program (Hungerford et al.) is the model that will be used for this purpose.

How Did/Do We Use Research to Plan Our Activities for Learning?

The *National Science Education Standards* (NRC 1996) are a primary guide for the development of learning activities at the LREC. The activities presented in professional development classes and workshops for teachers are correlated to the Missouri Show-Me Standards, and most are linked to the Missouri Curriculum Framework (benchmarks) for student knowledge and performance in science, communication arts, and math. As a program element in the Education Division of the Missouri Botanical Garden, the LREC contributes to achieving the goals of the Division.

Hart (1981) identified 25 key characteristics of environmental education to improve the conceptualization of the field and contribute to the theoretical foundation on which to base meaningful research, evaluation, and curriculum development. Of these, 10 are integral to and are used in various combinations in the learning activities and curriculum development of the LREC. The characteristics include interdisciplinary; multilevel; concepts (ecological-environmental); process development (cognitive, affective, skill-behavior); systems thinking; firsthand experiences and activities; present and future orientation; individual learning; team approach to teaching/learning; field studies (urban and natural environments). A study of the *National Science Education Standards* (NRC 1996) will find significant concurrence with these characteristics and those appropriate to good science teaching. Curriculum at the LREC for professional development of teachers and learning activities for students includes a multidisciplinary approach. Skills in written and oral communication and math are developed by students as they engage in the science and inquiry-based ecology activities.

Developmentalism, a curriculum theory that seeks to serve students by fitting the academic skills and behaviors to the child's stage of development (Uhrmacher 1993) is employed in activity planning at the LREC. Eleanor Duckworth, who studied with Piaget, promotes learning readiness to include allowing children to have their own "wonderful" ideas by placing them in developmentally appropriate problem situations. Furthermore, asking the right question at the right time can move children to peaks in their thinking that result in significant steps forward and real intellectual excitement (Duckworth 1987). As LREC staff and volunteers facilitate student-learning activities, they encourage the children to communicate their wonderful ideas. Follow-up questions by the facilitator are presented to help clarify student thinking and guide the inquiry processes.

The design of the learning environment at the LREC incorporates two of the four perspectives of human learning as identified by Bransford et al. (1999). In the learner-centered environment, our focus is on the knowledge, skills, attitudes, and beliefs about ecology that the student brings to the site. Ecology Center staff and volunteers use diagnostic teaching and prompt children to explain their knowledge constructs by asking them to make predictions about various situations and explain their reasoning (Bell et al. 1986). Often the student is engaged in cognitive conflict which may be resolved through the opportunity to discuss conflicting viewpoints with peers under the supervision of an adult facilitator (teacher, staff instructor, or volunteer).

The program is designed for a knowledge-centered environment to help students learn in ways that lead to understanding and the ability to transfer knowledge. Predictions of what students will understand about newly presented information is difficult without considering the knowledge the students bring into the learning arena. A further challenge is helping students to become metacognitive to make sense of the new information or experience and ask questions when they need interpretation (Bransford et al. 1999). At the LREC, when it supports the teacher's learning objectives for students, we place less emphasis on facts and greater emphasis on observation, exploration, building questions, and conceiving ideas of how to test those questions. Our quest is to help students understand the natural world through opportunities to make careful observations, think creatively and critically, and communicate their discoveries with peers. We strive to provide a suitable balance between engaging activities that promote student curiosity, as well as skills-building in equipment handling, data recording, and the processes of science, while minimizing the risk of overwhelming the students.

When the intended model of the learning environment is actualized, a formative assessment of student knowledge unfolds as students are asked a few basic questions related to the field study. Small groups of about six students work with an adult facilitator who guides the inquiry. For example, at the beginning of the Winter Ecology learning activity Animal Evidence Scavenger Hunt, the facilitator asks students what constitutes evidence and the changes they have previously observed of insects, birds, and mammals as these organisms prepare for winter. Questions about where animals may be found and how they obtain food in winter are posed. Additional questions help the facilitator determine the degree of previsit preparation the students received in the classroom. At the end of the learning activities, the facilitator asks questions relating to students' experience in the field to help them build meaning, place the learning into context, and determine if learning outcomes have been met (Marcinkowksi 1993). An observation checklist is incorporated into our activities to provide the facilitator with content and performance assessment measures. While teachers have explicitly stated that our instructors and volunteers are not to provide formal assessment notes on individual students, they are comfortable with our use of the checklist to provide feedback on the progress of each small facilitated group.

Most of the teachers who return to the LREC work with first- through ninth-grade students. Ecological foundations is a recommended major emphasis in an environmental education curriculum for these students (Engelson 1993). The LREC provides an appropriate field study site and support for teachers and their students to make ecological investigations possible and enhance the environmental literacy of these adults and children.

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Evaluation: Parks Project Sample

How Do We Assess the Informal Education Component?

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Illustrated in the various informal science education programs described in this book is a wealth of expertise and opportunities for successful science education outside the formal classroom setting. Parks, museums, botanical gardens, zoos, and scouting are just a few of the extraordinary informal education program settings where participants "can develop a better understanding of basic science, mathematics, and technology and of the implications of these fields in their everyday lives; are motivated to pursue further experience in these areas; and are aided in making informed, responsible decisions about issues involving science, mathematics, and technology" (NSF Summary of Awards p. i).

Program evaluation can be a powerful resource for informal science educators. Depending upon its purpose, an evaluation can identify the need for an educational program (needs assessment), test a program's theory of action (evaluability assessment), deliver information to educators for curricular and program improvement (formative evaluation), and convey outcomes of a program to funders and others for program justification (summative evaluation). As a result of the brief discussion of informal science education evaluation which follows, I hope readers begin to develop their own working definitions of evaluation, find the meaning and benefits evaluation can offer informal science educators, and, with this additional insight, nurture the interest and desire to incorporate evaluation into future educational efforts.

One caution: This chapter was difficult to write—saying in 1,500 words what I have studied and practiced for over 15 years. Therefore, my beliefs, values, attitudes, experiences, and biases have all played a part in what is and is not presented here. Readers will want to sort through this material and take what is meaningful, leave what is chaff.

What Is Program Evaluation?

Best described as an interactive process, program evaluation is "the systematic collection of information about the activities, characteristics, and outcomes of programs to make judgments about the program, improve program effectiveness, and/or inform decisions about future programming" (Patton 1997). A strong proponent of including stakeholders—those individuals and groups who care about the program and the results of the evaluation—in the planning and implementation of evaluations, Patton would argue that results of evaluations conducted using a collaborative stakeholder-based approach are more likely to be used. Unlike research, which has as its major goal to produce new knowledge (Babbie 1998), an evaluation's major goal is to produce information that can be and is used by real people in real life decision-making situations (Patton 1997). Therefore, the true test of a successful evaluation is the extent to which its results are used.

There are many professional evaluators in addition to Patton who have differing yet valid definitions of educational evaluation (Shadish, Cook, and Leviton 1991). In fact, the evaluation literature is brimming with models, theories, principles, and practices, and probably the best way to get a solid overview of evaluation is to spend some time reading these and other scholars' writings. But for the sake of simplicity and clarity, let us focus on one particular philosophy of evaluation and its related practices—that of the utilization-focused, stakeholder-based approach to evaluation.

However, before we move on, there is one more important aspect of informal science education evaluation: that of evaluation's relationship to assessment. Even though some formal and informal science educators might disagree, I believe that evaluation is not the same as assessment; in fact, there is a critical difference. Assessment has been defined as "a process of collecting data for the purpose of making decisions about individuals and groups" (Salvia and Ysseldyke 1998). *Program evaluation* information is used for decision-making about the program; *learner assessment* is used to make decisions about the individuals and groups involved in the program. Program evaluation is not the same as learner assessment; however, quite often, assessment data are an important contribution in program evaluation results (Harmon 1995).

Who Should Do Evaluation?

Evaluation, more an art than a science (Wholey 1994), involves the delicate balance of arriving at an evaluation that produces valid, useful results while maintaining the practicality of procedures. One response to the question of who should do evaluation is to more closely examine the collaborative, stakeholder-based approach to evaluation, implying that evaluation may best be conducted using a team of professionals and practitioners.

The stakeholder approach addresses both the concerns of informal science educators and evaluators. Stakeholder-based evaluation combines the expertise and interests of educators and evaluators as well as others interested in the success of the program and its evaluation to provide an evaluation plan that is relevant, focused, feasible, accurate, proper, and most of all, produces results that are used. Simply put, the educator desiring to conduct an evaluation works with an evaluator to establish a team of interested, committed persons to determine what evaluation questions will be asked, which methodologies and kinds of data will most likely produce believable and useful results, and how best to share the results. The evaluator, serving as facilitator, suggests alternatives, shares past experiences, and provides potential choices and processes. Depending upon available resources, the actual evaluation work can be done by the evaluator, or more likely, shared among the team members. This type of collaboration provides credible and affordable evaluation results and empowers educators wanting to build their evaluation skills.

A Stakeholder-Based Evaluation in Action

The following example illustrates the benefits as well as some of the difficulties of using a stakeholder-based approach to informal science education evaluation.

The Program. The Parks As Resources for Knowledge in Science (PARKS) Project is a large, national effort designed to improve informal science education provided to local schools by the National Park Service. Major goals included incorporating the *National Science Education Standards* (NRC 1996) into informal science education park programming and forming sustainable collaborations between formal and informal educators. Thirty-six teams of formal and informal science educators received funding to develop informal science education programs to be offered through 36 different National Park Service sites.

The Stakeholder-Based Approach

Stakeholder evaluation, chosen for the PARKS evaluation, supports collaboration among formal and informal science educators. The massive project included 36 diverse grant-recipient teams. Their size, geographic location, type of teachers and students served, subject matter addressed, and history of educational programming and collaboration demanded careful planning and representation. Organizations have personalities, cultures, and modes of operation that emulate the shared values held by the members of that organization. The National Park Foundation (NPF), the National Park Service (NPS), and the National Science Teachers Association (NSTA) all appeared to value collaboration and shared decision making, suggesting that the stakeholder approach was a natural choice.

The National Evaluation. The partners (NPF, NPS, NSTA) worked with the evaluators to establish a stakeholder team that was consulted throughout the entire life of the project and evaluation process. The evaluators provided the technical evaluation expertise, but the 18 stakeholder team members identified the evaluation questions (92 questions!), provided feedback on data collection instruments and processes, and reviewed preliminary drafts of documents and reports. It was the opportunity for direct input and buy-in from the beginning of the project from the major players that I believe ensured evaluation results were useful and ultimately used. Results from the national evaluation were used to guide future program efforts within the NPS, inform future grant-writing of the foundation, and certainly to support claims that the goals of the project were met.

The process of using stakeholders in this national project was lengthy, and some might suggest, cumbersome. In lieu of meeting face-to-face, stakeholders provided input via e-mail and conference calls. Decisions had to be made through cyberspace. We all felt a little disconnected compared to a traditional stakeholder process where members meet regularly to hammer out answers to questions, problems, and concerns and to make decisions. But the process worked. The evaluation was focused on decision makers' needs for information, the information provided was credible, and all interested parties had a voice in the entire process.

A Local Example

How does this national example transfer to a local informal science education program? The same way it did in the PARKS project. Being responsible for planning and implementing an evaluation at the local level, all 36 local teams of park educators and teachers involved in the PARKS Project were asked to form their own stakeholder groups for guidance on the local phases of their evaluations. In fact, local stakeholder teams provided input throughout the program development and implementation phases of the project. Local stakeholders included students and teachers, community members, local government officials, NPS personnel, nonprofit partners of the parks, and others interested in the local PARKS program. Each stakeholder team met throughout the life of the program (two years), helping to focus evaluation questions, gather evaluation information, and feed that information back into the program for improvement. Methods for information gathering included focus group interviews, student questionnaires and tests, teacher feedback questionnaires, observation instruments, and both formal and informal interviews. Experts were used to evaluate curriculum and other materials, and peer review teams were used on-site to help evaluate presentation skills. Each of the evaluations was tailored to the information needs of the local teams.

Based upon results of these local evaluations, a number of program formats were altered, several new audiences were identified, many sets of curricula were revised, and new partners were included in many of the collaboration efforts. Information was gathered that was used not only for program improvement but for justification of resources to local supporters and future potential funders for educational programs. Evaluation information was used to market programs to existing audiences as well as to share with targeted new ones. Working together, the local stakeholder team members became strong advocates of each other's programs and more cognizant of shared goals. One major outcome of these local evaluations was the individuals' and teams' growth that came from the process of working together.

Again, as with the national evaluation, I would say that using the stakeholder approach at the local level was more time consuming but yielded much stronger and more long-lasting results for both the formal and informal science education team members.

In Summary

What can be said about evaluation of informal science education programs? Here are a few thoughts for future consideration.

- Program evaluation is conducted only when there are people who care about an educational program (or potential program) and need information to make informed decisions about it. These people are called stakeholders, and not only do they constitute the audience for an evaluation, they are the very reason an evaluation should be conducted. No stakeholders, no need for evaluation.
- Program evaluation is a profession replete with standards and practices, a literature base, and strong theoretical underpinnings; thus, evaluation should be undertaken by individuals or groups who possess the knowledge and skills necessary to be successful. A stakeholder-based approach to evaluation can provide the needed expertise.
- Evaluation of any educational program is best conducted using a collaborative, stakeholder-based approach. Because most informal science education programs are a product of or a partner in collaborative efforts, the stakeholder approach to evaluation makes especially good sense for these programs.
- Evaluation is not assessment. Assessment, however, can be a part of an evaluation. Evaluation is not research. Research, however, provides various designs, methodological choices, and many other pieces critical to the evaluation process.

Because informal science education is growing in its contribution, evaluation of informal science education programs is a crucial part of improving science education nationally. Informal educators can and do make a difference in creating a scientifically literate population. Evaluation helps to illustrate just how much.

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At the Table—A Classroom Teacher and Informal Educator

On June 17, 2000, Joe Heimlich and Anita O'Neill met to talk about what informal science education means to each of them and what their perceptions are about its use in teaching. Joe is a professor at Ohio State University whose work and studies revolve around informal science education settings. Anita is an elementary school teacher in Montgomery County, Maryland. Their conversation was to last an hour, but they spent the better part of the morning in a lively discussion; highlights of which follow.

What does informal science education mean to you?

Joe: When I talk about formal, informal, and nonformal, I use the academic model that looks at the objective and means of teaching. Who controls the objectives? Who controls the means? When the objectives and the means are controlled by the institution or the educator, that is formal. When the objectives are controlled by the institution and the means are controlled by the individual, it is informal. When the means are controlled by the institution but the objectives are controlled by the learner, that is nonformal. There is a distinction, and I can see it more in a relationship to how the educator, the institution, and the organization relate to the visitors and the content and the environment. In the informal, the hook is the environment. Through that hook you can teach content to the learner. In the nonformal, they're coming for the class, the course, the workshop, the lecture series, and the tour. They're coming for that, and through the content, you can reach the environment. So I see them as different, although they blur. And even the formal blurs. A teacher like me—where's the formal, the nonformal, and the informal? It's all good teaching. Ultimately, I think that is what we need to look at—what is good teaching in whatever setting and for whatever purpose and what is it doing to support the learning for the student?

Anita: It is much more interesting doing authentic investigations versus looking at a textbook. I don't use textbooks in my classroom. If we are going to study symmetry, we are outside looking at symmetry in nature or we read *trade* books, very colorful picture books with photographs and things that support what we are trying to learn. To just sit and read a textbook—it's not happening. Next year I am going to be in fifth grade, so I am hoping to extend the excitement in fifth grade because I see it dropping off after fourth grade, which is unfortunate. We shouldn't spoil it for our students…. It's incredible, because even the kids who are the "at risk" kids, who typically don't do well in school, I see them going that extra step, making attempts at things. You read their records, and this is not something they would normally do. What saddens me is that I see them go back to a more traditional classroom, and they lose skills that I think that they gained in the short time we had together.

Joe: That hits my passion. That the informals have their own reasons for existence, separate from the school and in a real partnership, can be beneficial to the schools, the student, the teacher, and to their own goals. But I think in a lot of cases the informals try to serve the schools' goals to the exclusion of their own goals or conversely, "We're here. We're a wonderful resource. You can come use us, and we don't care about you." The partnership doesn't exist. I really think that it should be a part of the school requirement, but not mandated. But rather, the teacher and the informal provider together define, "When does it best suit your needs, as a teacher, to come to us? Here's what we can do." I think there's a great opportunity, but we are not seeing it really come to be.

(To Anita) The informals to me are the bridge to the real world for the schools. Teachers like you are so wonderful because you take kids out and really do applied learning. Even there, going beyond the teacher as expert, to something in the community where someone else is present and engaging with the students. It's a connection of the school to the community and back. I think that bridge is so vital for understanding application. And if, as informals, we were clearer on saying, "I have a great job and here's what I had to learn to do it," it would be so much more valuable than just, "All right. You're here. Here's your activity. Do it. Isn't it fun? Goodbye." And the kids go, "Wow, I want to be like you. I want to be a park ranger when I grow up because you get to do all these cool things." I think that bridge needs to come from both sides.

Anita: I have talked to parents when they come to Back to School night and asked what I was going to teach. I will say, "Having been outside the system, I feel like I am more compelled to teach your child the social skills to be a productive person versus whether they are going to learn to write in cursive. Don't ask me when they are going to learn to write in cursive. They might learn to use the computer, but more importantly, they're going to learn to work as a team and to use resources and to cooperate. Those are the important skills that they're learning." Everything else will fall in place if these are in place. But I am more compelled to say this, having to work with people who never picked up on their social skills—people who were just so antisocial, they couldn't work in a team. They couldn't meet deadlines. They couldn't go get information that they needed by themselves. I found that very frustrating—working with people who were highly educated people. Some were wonderful scientists, but just dysfunctional as workers.

We talked about how the lines are blurring between formal and informal. I don't know that I have separated the two in my mind. I see these are the things that my students need, that I need to be doing to address their education. I consider myself to be very resourceful, so I go everywhere to try to meet those needs, so if it means a field experience, then it means leaving the classroom.

What gives informal science education its power?

Joe: I think that the dominant power is in the effect. I have learned as an educator what to get these students excited about—if it's in a science museum about science, not about a specific question, but just wow, this is cool, this is fun. I want them in the zoo to say animals are really amazing. I want them to go to the Grand Canyon and stand on the rim and go, wow, it's big, and not even be able to fathom because 12 miles doesn't cognitively make sense until we go back to the classroom and suddenly we do some cognition, some activities that bring it down to the real cognitive structure where I experience a mile cognitively, then I can reflect on that "wow" and it becomes even more relevant.

Anita: Well, yes, you go out and you're marsh mucking, and you're going out and setting crab traps—you're talking about being able to reflect and to think. You have a lot of quiet time. You're not bothered by phones, TV, radios—it's a great learning environment...and most of the interpreters are very good at telling the kids how great their level of knowledge is so that they feel great about having to spend the time and do the activities.

How do *Standards* and informal science education fit?

Joe: What I really like about the *Standards* from an informal perspective is that the majority of them aren't about content. They are about the teacher. And to me that is one of the values that we have in these kinds of partnerships. The professional development piece is the one that is most lost in the *Standards* and the one that, when I first saw it, I thought, "That's cool." We all need this professional development and if we make it a standard, it's really exciting. Who is enforcing it? While we're

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being driven by the tests, they are enforcing the content and the student process, not the teacher process.

(To Anita) What you're doing this summer—the problem-based programming growing out of the medicine field—is a phenomenal program. Wow—what professional growth! How many teachers can do that, or are willing to do that, or are exposed to the opportunity to do that?

Anita: One thing I like about Maryland is that our MSPAPs are focusing on processes. There are certain content areas that I feel they need to cover, but definitely it is written by processes. Students can compare and contrast. Students can apply their learning to a different situation, and students can solve problems. I think a lot of people thought these tests would go away, and they could just teach content. They are not going to go away, and they are evolving. My understanding is that they are changing some of our objectives to more closely match the national standards, which is good, because when I look at it, they are skills that we should have. These are skills that you use every day as an adult, whether you're a scientist or a regular person. They are practical skills, and people say that it's really what the students should be tested on, and they need to be tested on.

How do assessments and informal science education work together?

Anita: I am not a big fan of formal assessments.... They have their place, but I don't believe that that is how we should measure the learning of our kids. Observing what your children are doing—observing and listening to the conversation they are having, the questions they are asking, how they are applying that to other situations—that's how we should assess. And if you're working with an informal educator, it has to be that dialog. "Oh, did you notice so-and-so started?" and then you take that informal assessment and you feed it back into your future plans. "Oh, this will be a great follow-up trip or follow-up visit, or this activity will really help try to make these concepts a little more concrete because they sort of have it, but there are some misconceptions there."

Joe: With the school relationship, I want to be able to rely on the teachers to say, "Here are the skills. Here is the content that you have and I want transferred to my students." Then the teachers will take responsibility for creating the frame for knowledge, with the experience that they have. So, if they come to my museum, and we have this special show and there is an historic person—a photographer—and the class is studying that point of history, I don't have to try to teach them history. I can share the photographer and give them context and rely on the teacher to make it relevant to the curriculum, and I try to make it relevant to the students' lives. That is what I mean about the bridge. The informals can make that relevance.

What are some systemic challenges to using informal science education?

Joe: There are some schools that I have worked with where we have had to struggle to even get the teachers to be allowed to go outside the building into the schoolyard to do a class. *Heaven forbid they should dare use the hallway and disturb other classes.* There's a real unevenness there. On the other side, there's a real unevenness about the teachers' willingness. There have been several studies looking at teachers, especially with field experiences. A lot of studies have been done looking at the barriers, and a couple of studies just in the last few years have gone beyond the barriers to, "What if the barriers were removed?" Then what would keep them from it, and if that were removed, what would keep them from it? Basically, it turns out that we have a proportion of teachers, probably a normal occurrence, that says they just don't want to. Number one barrier is always time. " I don't have time to take the class out in this short period, do this, and then come back. I lose too much time." Another one is money. Those are very real barriers, but they can be dealt with. The ones that are much harder are the fear of the content, especially in the science arena. The teachers of natural science and the earth sciences don't feel that they know the answers, so if they take their kids to the science museum and the kid asks, "Why?" or "How?" and they don't know the answer, then they are a bad teacher. If they take the kids outside and the kids say, "What is this?" and they don't know, then they are a bad teacher. Or if they take them to a zoo and they don't know about the animal, they are not a good teacher. There's this fear of not knowing that keeps them from going out there, and I think it is hard because they don't know how to use—or haven't been trained in how to use—inquiry as the method where they don't have to be experts, and that is a struggle.

Anita: I guess I have been lucky in that the administrators that I have sought to work with have been very supportive. They are risk-takers themselves and they have modeled that for me as a teacher, and I try to model that for my kids. But I know what you're saying. I hear people say, "Oh, my principal wouldn't let us do this," and I say, "How can you even work for someone like that?" I am hoping that with this great influx of new teachers, because one-third of the population of our teachers are retiring, that we're going to see more change, because these teachers have gone through a different mode of instruction in their methods classes and hopefully have a different mindset—maybe younger, more risk-taking.

What are some other challenges to the formal/ informal mix?

Joe: On the other side a lot of those in the informal and nonformal arena know that the best way to get teachers in the summer for professional development is to be able to pay. But the majority of the informals are environmental and there's very little money. It's lower paying than most teachers, and the grants that the zoo or a park or an aquarium gets are a few thousand. You can't pay teachers to come to a workshop for a couple of thousand-dollar grants. The big grant monies that pay for teachers are the NSF grants, the major grants, and those are difficult for the informals to be part of, and if they are, they are usually subservient to the formal system and they lose some of the economy.

Anita: One of the other professional developments I am doing is the Chesapeake Bay Foundation, which I was telling you about. We are not paid. Our county pays for it through a grant through Howard Hughes. I think this summer there will be a total of about 45 teachers going.

What opportunities do you see for collaboration?

Joe: The informal and nonformal arena is huge and the opportunities are very diverse. Even in the small rural areas, you not only have the parks, monuments, tourist attractions, informal education. Zoos, aquariums—those tend to be urban, but not necessarily. You have petting zoos; there are little roadside attractions…the churches increasingly are coalitions of cross beliefs….The relationship they can have with the schools could be phenomenal and yet is rarely there except for the early childhood inoculation. And yet they do these phenomenal lead interventions; they have great resources for the parents; they could do it with the schools; the kids could be part of their projects and measurement. The opportunities are phenomenal. We tend to look simply at the most convenient, or at the most obvious. Rather, for me as an educator, I look at what I am teaching and what kind of experience would best support that and then look for creating that experience for my classes. Maybe it's touring a playground with a parks manager talking about safety and the way things are constructed and why there are chips or rubber. Whatever is appropriate again—that gets to the need of reflection. On both sides we need to reflect and say what can I do, what's appropriate.

Anita: Through this whole thing we are talking about the importance of the relationship, and it comes back down to whose responsibility or whose turn is it to get this partnership, and I feel as a classroom teacher I am trying to develop it, and sometimes it does feel like a one-sided situation, and something has to happen so that everyone buys into this. I don't have any proposed solutions, but we have this new superintendent whose creed is to raise the bar and close the gap. I keep saying, until you get parents involved, the gap is going to remain. We can raise the bar, and the gap is just going to get bigger because we need to get monies and pour it into parent education, society education. The difference between the kids in my class who are deemed at risk and the kids who are deemed gifted and talented is the outside experience. The kids who are doing informal enrichment, or through programs like Hands On Science, they have background knowledge and it is easier for them to make those connections. The kids who go home and play Nintendo and watch TV and whose parents do nothing with them are the kids who never get it. They don't have any background knowledge to relate the new concepts to, and so somebody has to pour some money into this parent.

Joe: From the informal and nonformal side, because so much of the experience is affect, but it is solidly based in the varied disciplines, what parents often hear about field experiences and experiences are how fun they are. I am saddened because in our society, education is not supposed to be fun, but it should be. It should be exciting. After a lot of complaints about experiences to teachers like "they had fun, what did they learn," we begin to figure out as a partnership how do you document that the experience—not only was it affect and positive reaction, but it was affect learning and led to cognitive learning. We really need to work together to see how we do that so that we can say to parents, look at what they gained, and here's the evidence which then supports doing more.

Who We Are—Informal Science Educators

In this book, informal science educators speak about the histories and research in their settings. We asked them, "How did you come to do this work?" They wrote of early exposure, family encouragement, predispositions in some cases, and accidents of fate in others. Their stories are interesting in and of themselves, but may also give you more material for career awareness activities. The book's contributors appear in alphabetical order.

Elaine Andrews

I guess you could say that I've always been a nonformal kind of person, preferring the learning that comes along with real life over textbook learning formulas. That's not to say that I didn't enjoy school. I did. We are blessed with fine educators in both the formal and nonformal sectors.

In high school and college, my most cherished learning experiences happened after school: in Science Club, Girl Scouts, music study, and nature study with my mother. After completing a masters' degree in science education, my first teaching assignment took place in a "school without walls" in downtown Chicago, followed by a job in a school for emotionally disturbed teenagers located on the wooded grounds of a psychiatric hospital near Milwaukee. Later, I worked with high school dropouts in downtown Detroit. In each of these schools, the standard classroom structure could not meet the needs of the youth I taught. Coupled with the challenge of responding to the intense personal needs of these youth was the problem of how to inspire youth with a curiosity about science and a love of biology in the sterile environment of an underfunded classroom. Something else was needed—perhaps a better link between the classroom and outside resources would help. Innovative approaches, taking advantage of the resources beyond the walls of the school and tied to the real lives of these youth, led to increased motivation and success with learning.

I aspired to a position as director of a school-based nature center to better accomplish my goals. To make myself more employable, I completed a second masters' degree, this time in natural resources policy and management, with an environmental education emphasis. Here at last was an approach—environmental education—that provided a more holistic and relevant methodology for biology education. But a move to Madison, Wisconsin, eliminated the possibility of a job as a nature center director. In 1978, Madison had no nature center. Several natural areas owned by the university and the schools provided outdoor experiences for school-age youth, though, and I worked as an hourly employee for these organizations.

An opportunity to match my preferred method of teaching with a job finally materialized with an appointment as program manager with the University of Wisconsin Extension. My new job providing adult environmental education opportunities had to pay for itself. Course fees had to pay for my salary, my assistant's salary, teacher salaries, all instructional and marketing costs. To survive, I had to be successful at providing exciting learning opportunities that would entice adult participants at an affordable cost and at a convenient time and location. We were very successful, annually engaging over 2,000 students to participate in 100 short courses.

The skills I learned to make this award-winning adult program successful became the foundation for my lifelong professional focus on community-based education. I now work with County Extension offices and government agencies to design non-formal or "volunteer" education. Our "students" vote with their feet. Youth and adults attend programs or teach themselves because they want to learn. Some of my landmark programs include Give Water a Hand: A Guide to Youth Action; Educating Young People About Water—Resources and Training for Adult Leaders and Natural Resource Professionals; and Community-Based Environmental Education (CBEE) models for EPA and Extension professionals.

Bruce L. Carr

Early fascination with animals and nature persisted through an outdoor childhood. Following college and the U.S. Army, genetics captured my imagination and I became an organizer for graduate study. And what a world view it opened, linking chemicals to cells to organisms to populations to ecosystems—throughout time. That beauty remains the core of my life as a scientist.

The technical work of a college professor pursuing new knowledge left me fulfilled but also wanting. Scholarly exchanges in quiet enclaves taught me much and remain a treasured memory. But mainstream issues surrounding environment, biodiversity and conservation, and my love of the educator role renewed my search and took me to the St. Louis Zoo.

Informal science education in accredited zoos and aquariums offered all I was searching for—important messages that must juxtapose science with human actions, an audience that includes everyone, issues critical to the welfare of natural systems (including humans), and a terrific community of colleagues and community partners. The work is full of wonder. I have seen the Pandas at Wolong and Darwin's finches on the Galapagos. Both still offer many lessons. Colleagues from Mesoamerica honored me as an invited trainer in Costa Rica, working with international colleagues to organize cooperative conservation and educational approaches. My work with AZA offers even broader international partnerships.

The glamour of zoos and aquariums surrounds our stars—the animals. Curators and keepers stand in that light. At times it seems that educators don't have a species. But we do. The Educator's Species. Humans. The species that stands in every picture. The species that will, either by action or inaction, ultimately settle all questions of endangerment and extinction. The only species that can devise an inclusive and humane future for the earth's biodiversity, which includes humans and the welfare of their populations and societies. My work as an informal educator lets me dream that humans just might improve upon the four horsemen. And that is enough for one life.

Peggy Cole

I met Alan Friedman when we were both on the faculty of a mid-career, professional museum-training program called Museums Collaborative. He was working in Paris, helping the French set up LaVilette. I was working as an independent museum consultant. My background was in art, English, and developmental psychology. I was science-phobic and somehow managed to escape taking chemistry and physics ever.

I had a Ph.D. with a specialty in curriculum and teaching. I had worked with many key Piagetians and my dissertation was on Piaget's work. I had been on the graduate faculty at Bank Street College of Education for 14 years where I taught learning theory and child development along with supervising in-service teachers. When Bank Street started a museum program, I taught in the program as well. My specialty was the application of developmental-learning theory to museum audiences. I had also been the prinipcal of an independent elementary school in New York City and for many years, a classroom teacher.

When Alan was offered the job as director of the New York Hall of Science, he called and asked me to join the staff as education director. I told him I couldn't possibly do that because I didn't know much about science. He thought my lack of experience would be helpful since I would have the perspective of a general public. I decided to join the staff. The rest is history.

Lynn D. Dierking

As an undergraduate, I majored in biology and had every intention of pursuing graduate degrees in biology, with an emphasis in ecology. However, within days of graduating, Wit Ostrenko (now director of the Museum of Science & Industry—Tampa) called, offering me a position teaching a marine biology course in a summer camp program at the Miami Museum of Science. I also was a facilitator for the Museum's camp-in program. I was so totally captivated and transformed by these early teaching experiences that I changed my career path and consequently obtained a teaching credential and became a middle school and later a high school science teacher. Although I enjoyed being a classroom teacher, what I realized was that the learning I preferred to understand and facilitate was that which occurred in museums and other free-choice learning settings. As they say, the rest is history! Thanks to Wit and three additional important mentors—Edward Munyer, John J. Koran, Jr., and John H. Falk—I have spent 25 years pursuing my research and development interests in this arena we are now calling free-choice learning. Currently, I am associate director of the Institute for Learning Innovation, a nonprofit organization whose mission is to understand, facilitate, and communicate about free-choice learning.

John H. Falk

I have had a long-standing interest in understanding and facilitating learning, initially sparked by my experiences as a summer camp counselor. My first real efforts to promote learning were developing biology and ecology-oriented learning experiences, initially for after-school programs at the Lawrence Hall of Science, Berkeley, and then as an educator at the Berkeley Botanical Garden. Very early on, I came to appreciate how important it was to distinguish between the words *learning*, *education*, and *school*—words that historically were treated as synonyms. In the process, I became committed to understanding and furthering what is now known as *free-choice learning*—the learning that individuals do because they want to. This has been the focus of my research and educational activities for over 30 years. I was involved in the very first National Science Foundation-funded out-of-school science education materials development effort, the Outdoor Biology Instructional Strategies (OBIS) project. I also established the first research and development group devoted to out-of-school learning, the Smithsonian Office of Educational Research. Currently, I direct the Institute for Learning Innovation.

Shalom Fisch

I made the transition from developmental psychology to informal education by accident. In stumbling across Gerald Lesser's book, *Children and Television: Lessons from Sesame Street*, I discovered a world in informal education by accident. I discovered a world in which empirical research with children informed the production of effective educational television. Intrigued by the idea, I took a summer internship at Children's Television Workshop, little suspecting that I would still be at the Workshop 14 years later. During the intervening years, I served as research director for numerous media projects, including several aimed at promoting mathematics, science, and technology among children. Today, I am the vice president for program research at the Workshop, overseeing curriculum development, formative research, and summative research for a broad variety of television series, magazines, CD-ROMs, and online materials. My motivation remains the same as ever—to use research, good educational practice, and the power of engaging media to help children learn—but it has taken on a more personal dimension since the birth of my two children (and personal subject pool), Nachum and Chana.

Yolanda George

I grew up in a black Catholic family in New Orleans while the schools were still segregated. These circumstances dictated that I would attend schools that were segregated by both race and gender. The Catholic school in my neighborhood was for white students only, so I was bused to the black Catholic school and later commuted to high school in the French Quarter, right behind the St. Louis Cathedral. That high school building was later sold by the nuns to a large hotel chain. It was the nuns who encouraged me in science. My parents thought I should prepare to be a doctor or a teacher, because those were well respected professions with which they had some acquaintance.

I was in an all girls' high school and then attended Xavier University of Louisiana. I studied biology in graduate school at Atlanta University. Starting in a co-op program, I started working at Livermore Labs in 1973 as a bench researcher. I met and began working with Nancy Kreinberg at the beginning of the "Expanding Your Horizons Conference" at Mills College in California. That conference is now in its 25th year. I worked with Nancy on Math/Science Network before the Equals project, as a consultant, and still continue to work with Nancy as part of the collaboration for Equity in Science, Mathematics, and Technology. I then got a job at the University of California at Berkeley as director of professional development programs working on a precollege program for girls and minorities; college retention in science and mathematics; and pregraduate preparation for science and mathematics graduate programs. I moved to Washington, D.C., and worked for the Association for Science and Technology Centers (ASTC) as their development director and came to the American Association for the Advancement of Science (AAAS) about 15 years ago and co-started the Black Churches Project in 1987, as an outgrowth of the Science Linkages in the Community project. I like turning folks on to science who wouldn't ordinarily be turned on, and that keeps me going.

Joe Heimlich

I came from a family of teachers. My dad was an award-winning teacher. He is retired now, but taught history in high school. He was offered a position at the university and turned it down because he liked teaching at the high school level. My mom started off as an English teacher in middle school. While we were all young, she stayed home and then became a librarian in a small school district in Attica, Ohio. I went off to college on a music scholarship and really wanted to be in theatre. I put myself through college doing theatre, predominately musical theatre and dance. I had an accident, so that career ended just before graduation. But it was good. I had a lot of job offers people never got. At least I felt that I could have gone there. I started doing some consulting work in communications and presentation platform skills. I then started working with the U.S. Extension Agency and immediately was thrust into the nonformal teaching arena. I was in community development. At that point I was also working with youth development. I realized that I really should be in education, so I stayed at the university and got my doctorate in educational theory. I started work in environmental issues, and upon graduation I moved into a position in environmental education.

Phyllis Katz

I was a New York City kid who grew to know the world from the playground sandboxes, to the city's rich array of museums, zoos, parks, and libraries—and abundant tenement wildlife. I knew a whole lot about the habits of mice and cockroaches, but more important, I didn't grow into the mold of the stereotypic squeamish female as I helped to solve the problem of cleanliness.

I was born to parents who had made it through the Depression without fulfilling their immigrant parents' dreams of a higher education. Both my father and mother loved learning. My father earned his living as a butcher—his Army trade. He loved classical music and read philosophy as a hobby. He brought home chicken and lamb skulls for us to hold and compare. My mother trekked us around to the zoo, the library, the theaters. I remember how excited I was when I could sign my name and get my first solo library card, somewhere around eight years old. I read every science fiction book in the children's section. I was brain-tickled by the possibilities of what might be. My mother was determined to get a higher-education degree, and she modeled the studying, working homemaker before anyone had uttered the word "supermom."

My academic journey and work history are a marbled blend of activity and reflection. I went to the city's schools right up through college and majored in English because I did love to read and write. But after teaching for several years, I decided to return to school to pursue science. I was fascinated by animal behavior and interspecies communication. I married my husband Victor, a mathematics historian, with whom

I continue to have many good conversations about teaching and learning. We have three children. I began the Hands On Science program in 1980 and then returned to school again in 1990 for graduate work towards a doctorate in science education to focus more deeply on the learning process in this setting. It is an interesting world with lots of work to do and many pleasures in the doing. I continue to create, train, and now do research in community-based informal science education.

Harriet Mosatche

I had been a professor for 12 years in a small college in New York City, with six of those years as chairperson of the psychology department. Although tenured, I was interested in pursuing a new chapter in my career, particularly since I had just published a book and found out how much I enjoyed nonacademic writing. An ad in the *New York Times* caught my eye—it was for the position of director of program development for the Girl Scouts of the USA, and the description indicated that writing for girls and the adults who work with them would be a significant part of the job. Although I had never been a Girl Scout as a child, I was intrigued by a position that would allow me to reach millions of kids within the context of informal education. Where else would I have the opportunity to apply my education and experience creating fun, educational, and developmentally appropriate activities and projects for girls from five to 17? I later became the principal investigator of a project (funded by Girl Scouts of the USA/Franklin Institute Girls at the Center and the National Science Foundation) that encourages family involvement in girls' science learning.

During the 15 years I have been working for the Girl Scouts of the USA, either as a staff member or as a consultant, I have learned about the integral role science plays in the Girl Scout program at all age levels, from the youngest Daisy Girl Scout to the senior in high school. For some girls, Girl Scouting provides their only real, hands-on science experience. I wish I had been involved in such a project when I was a kid.

Emmalou Norland

My mom would say that, from the time I was born, I always had an opinion about everything. Now other people actually hire me to share my opinions with them and to help them gather data to formulate their own! ("See, Mom, I told you my arguing would be worth something someday.") Actually, program evaluation was something I ended up studying originally by default in graduate school. At the time I attended graduate school, I was a single parent with two small children. To facilitate childcare, I always was sure to sign up for at least one statistics course and one research methods or evaluation course every quarter. Why? Because the kids could go with me to the stat lab (they spent many a late evening there waiting for Mom's printout to be generated by the mainframe computer). It was much harder for them to sit quietly in some library. The stat lab was loud, exciting, full of people, and had lots of cool machines (keypunch back then). By the time I graduated, both my children and I were experts in evaluation methodologies. Even today they still have a strange attraction to asking questions that end with the phrase "circle all that apply."

My favorite part of helping others with evaluation strategies is watching how evaluation facilitates program development. If educators use evaluation throughout the program development and implementation phases, it is such an empowering experience.

Anita O'Neill

I always wanted to be a teacher. My parents were not very supportive of that idea. They grew up in a rural area and teaching wasn't necessarily something they wanted their kids doing. Plus, my mom worked in the school system, which was not very good, and she saw the bad end of it. So she wondered, "Why would you subject yourself to that?" So, I did some other things. I joined the Air Force and was an intelligence analyst. I got a degree in business. When I got out of the Air Force, I worked in the high-tech industry, managing programs for military purposes. I decided after I had my daughter that it was time that I went back to get my masters' degree in teaching. I quit my job and went back to Hopkins and got my masters' degree in teaching, and I love it. I am a lifelong learner—I think that you need that to be a good teacher—and I have a blast. Every year is full of surprises. I feel like I generate a lot of enthusiasm in my students. I hear that from them and from their parents. I am kind of a big kid myself, so I am a good match for the kids. I am curious, so we feed upon each other. In addition to being a formal educator, I also do some informal things after school, like teaching in the Hands On Science program.

Celeste Prussia

I grew up in northeastern Connecticut, a rural and economically depressed area settled by Canadians who took jobs in the textile mills along the strong rivers that provided hydroelectric power. Most of my spare time as a child was spent in the forests and fields (too much poison ivy near the river!) where I investigated anything that caught my eye. Crawling, climbing, running, mucking, and poking were my maneuvers. Much of my tendency to interact with the "critters" was virtually lost in the transition from elementary to high school. Gaining wheels at 16 years gave me mobility to venture further to find unexplored watercourses, granite ledges with panoramic views, and little places of heaven in the tall pine/spruce forests that dotted the landscape. The tendency now was to look at the big picture rather than inspect the details.

As I approached the final requirements to obtain an associate's degree in arts and sciences from a local community college, I faced the dreaded "college biology" course. So many warnings from my peers of boring classes and ridiculously hard tests raised my anxiety and premonitions of blowing my honors status. The course, as it turns out, was fabulous, led by an inspiring, encouraging, "oh-wow", Bill Nye-kinda guy named John Kuckle. We used radioisotopes to see where nutrients moved in plants, milked sea urchins to get sperm to fertilize eggs in a petri dish, learned to use a 35 mm SLR camera and even process and print our own black-and-white film. This was a real turning point for me, and from that point forward, I became a biology student, a junior scientist, and eventually a researcher—all thanks to one teacher who practiced hands-on, minds-on science. The completion of undergraduate and advanced degrees in science would never have been a reality for me if it hadn't been for that inspiring teacher who was a great role model for my current teaching approach. Today I balance my detailed inspection of organisms in forests, fields, and wetlands with a holistic view that helps me teach about ecosystems.

Joel Schneider

When I was in school, I spent a lot of my discretionary reading time on science fiction. One novel involved a time machine in the shape of a "three-dimensional snowflake curve." Figuring out what that would look like started me on the road to becoming a mathematician and even led to my first publication. Over the years I did some research and some university teaching, drifted into math education, worked with schoolteachers, and developed curricula. At one point, I found myself at Children's Television Workshop developing computer software. When the company decided to produce a television series about mathematics, the bosses asked me to take on responsibility for the math. Despite my initial skepticism about mixing math and television, *Square One* turned out to be successful in many ways, as well as a lot of fun for us to make. Working on *Square One* put me into the informal education business in a serious way, and other projects allowed me to continue to pursue it. I'm amused that, even though chance has been a major factor in my zigzag career path, the initial and current points are both in popular media. I wonder what might be next.

Tom Smart

As a small child I thought I was a scientist, studying frogs and toads, turtles, spiders and insects, birds, and collecting rocks. I loved to discover things and figure out how things worked. I became involved in Boys & Girls Clubs and began trying to help young people share my enthusiasm for discovery.

I have spent my entire life working in and on behalf of Boys & Girls Club kids, having grown up as a member of Boys & Girls Clubs in Detroit and then serving over 20 years as a professional staff member. As director of program planning, I am currently developing a science program (Dragonfly Quest) and a health and fitness program (Body Works). I have written some of the most popular and widely used program publications in Boys & Girls Club history. These include Back Pocket Program Hints and The Ultimate Journey, an environmental education program that was recognized by the North American Association of Environmental Educators as the "most significant contribution to the environmental movement by an organization."

I spent my high school and college years working at Boys & Girls Clubs and Club resident camps. Upon graduation I embarked on my professional career in Boys & Girls Clubs. I have been deeply committed to the value and importance of a program that is fun, engaging, and meaningful. For 11 years I worked in various positions with the Boys & Girls Clubs of southeastern Michigan. As a member of the social recreation staff, I developed a number of award-winning programs, including Games People Have Always Played and Around the World in 80 Days (fun ways to teach reading, geography, and history). In the area of citizenship and leadership development, I organized the Flaming Eagles Keystone Club, which developed and implemented a series of nationally recognized programs. I was struck by how winning awards changed the way young people viewed the world around them and their perception of what they were capable of achieving.

Academically, I was a National Merit Scholar, attended Wayne State University, and earned my bachelor of science degree in American humanities at the University of Indianapolis.

George Tressol

Blame it on my mother—she said "You're cute!" and I believed. She cultured a five-year-old who roamed the library stacks alone and read voraciously. In the midst of the Great Depression, she made learning our family's entertainment. Our greatest adventures were forays to the Field Museum and the Rosenwald Museum (now the Museum of Science and Industry) for the few cents' cost of a long streetcar ride. Our toys and presents were often junk—a battery, some nails and a roll of wire (make your own telegraph); a sewing needle, string, paper, and an old record of "We're All Going Calling on the Kaiser!" (make your own phonograph); newspaper and wallpaper paste (make your own puppets). Learning was always the greatest, most exciting adventure, and I came to believe that school was just another way to learn...what else could I conclude?

Having grown up in a milieu of learning as entertainment, I expected to always be entertained. And so I have. First, I was a professional voyeur of science, later a professional explainer of science, then an advocate for informal learning (for and through entertainment). And finally, I became an evangelist for a holistic approach to education, both outside and inside the classroom—before, during, and after formal studies. What can I say, my parents made me do it!

Julia Washburn

Never doubt that those engaging educational experiences we facilitate for children have a profound effect. I often joke that I started my National Park career at age seven as a Junior Ranger at Rock Creek Park. Twenty-five years later I found myself to be the Chief Ranger of that special National Park in the heart of urban Washington, D.C.

While I'm sure my experience as a Junior Ranger contributed to my love of nature and helped shape my desire to share that love with others, many other factors also steered me on my life journey in conservation education. I spent many long hours as a child seeking out secret forts under bushes or among the branches of fallen trees in the woods. My fourth-grade teacher complained that my handwriting was poor—I had been doing my homework in a tree. My mother loved animals, and we always had tanks of fish and frogs, guinea pigs, and other creeping creatures in our home. She and I shared Girl Scouts; she as leader, me going from Brownie to Senior, camping, canoeing, hiking, cross-country skiing, and singing together outdoors. These experiences together led me to become a camp counselor, biology major, and a Park Ranger, which led me to pursue graduate studies in museum education.

Now as the Senior Director for Grants and Programs at the National Park Foundation, I am blessed with the opportunity to help Park Rangers across the country facilitate wonderful learning experiences for young people. Our interactions with children, helping them connect with real places and do real science, do make a difference. They did for me.

Vanessa Westbrook

My story of becoming connected to informal science education is perhaps an interesting one. In 1992, I inquired about an ad that addressed the need for a teacher to teach science to museum school students on Saturdays and during the summer. This job was part-time, and I was currently teaching fifth grade in the local school district. Needless to say, I was hired for the job! This began my professional experience with museums. The staff at the museum welcomed me into its niche, and soon I began to actively participate in decisions and scheduling for fall, spring, and summer classes. I began to merge the teaching job at South Fort Worth Elementary and museum school job. Students from my fifth-grade class began to enroll in museum school, and I began setting up exhibits (borrowed museum resources and bio-specimens) around the elementary school in display cases and in various places throughout the school. Two things happened because of this. Families from the school began to visit the museum regularly, and parents began requesting scholarships to send their children to summer science camps. My idea of starting all girls' science classes on Saturdays was well received by museum staff, and filled quickly with students. In fact, the following semesters required two or more class offerings for the number of girls requesting a spot in the session. My career at the school district was also moving ahead. I was promoted to elementary science specialist for the district and reassigned to a magnet school where my office was housed. I continued to teach at the museum; however, my class offerings decreased due to more responsibility in the school district. After being appointed to a state committee to write the state framework, I had to give up my position at the museum. The museum, in return, asked me to become a science education consultant and adviser. I happily accepted this task, and soon other informal institutions contacted me about being on their advisory boards. The University of Texas at Austin's Charles A. Dana Center offered me a job as an elementary science and math education specialist, which I gladly accepted, since I was consulting with them on a regular basis. Within a year, I was promoted and given the additional responsibility of leading the informal science group. To end this long story, I now co-lead the Informal Science Education Association of Texas. This organization has a membership of 100+ educators who work in an informal learning institution of some kind. I serve on several boards of informal learning institutions around Texas. And the work is continuing!

Web Resources

4-H

4-H the youth education branch of the Cooperative Extension Service, a program of the United States Department of Agriculture. Each state and each county has access to a county extension office for both youth and adult programs. 4-H inspires young people to continue to learn and grow, to make their best efforts better through participating in educational experiences.

www.4-h.org/

AAAS

The American Association for the Advancement of Science (AAAS, pronounced "Triple-A-S") is the world's largest general science organization and publisher of the peer-reviewed journal *Science*. With more than 138,000 members and 275 affiliated societies, AAAS serves as an authoritative source for information on the latest developments in science and bridges gaps among scientists, policy-makers and the public to advance science and science education.

www.aaas.org/

AABGA: American Association of Botanical Gardens and Arboreta

AABGA's mission is to support North American botanical gardens and arboreta in fulfilling their missions to study, display, and conserve living plant collections for public benefit.

www.aabga.org/

AAM: American Association of Museums

The American Association of Museums is the national organization representing the museum community and addressing its needs, thereby enhancing the ability of museums to serve the public interest.

www.aam-us.org/index.htm

AZA: American Zoo and Aquarium Association

Established in 1924, the American Zoo and Aquarium Association (AZA) is a professional organization dedicated to the advancement of North American zoos and aquariums through conservation, education, scientific studies, and recreation.

www.aza.org/

ASTC: Association of Science-Technology Centers, Incorporated

The Association of Science-Technology Centers, Incorporated (ASTC), is an organization of science centers and museums dedicated to furthering the public understanding of science. ASTC encourages excellence and innovation in informal science learning by serving and linking its members worldwide and advancing their common goals.

www.astc.org/

Boys & Girls Clubs of America

The mission of every Boys & Girls Club is to inspire and enable all young people, especially those from disadvantaged circumstances, to realize their full potential as productive, responsible, and caring citizens. Boys & Girls Clubs provide a safe place to learn and grow; ongoing relationships with caring, adult professionals; and life-enhancing programs and character development experiences.

www.bgca.org/

DiscoverySchool.com

DiscoverySchool.com is dedicated to making teaching and learning an exciting, rewarding adventure for students, teachers, and parents. DiscoverySchool.com provides innovative teaching materials for teachers, useful, and enjoyable resources for students, and an entire store full of helpful learning products for parents to share with their children. The site is constantly reviewed for educational relevance by practicing classroom teachers in elementary school, middle school, and high school.

www.school.discovery.com/

Exploratorium

The Exploratorium's mission is to create a culture of learning through innovative environments, programs, and tools that help people nurture their curiosity about the world around them.

www.exploratorium.edu/

Girl Scouts of the U.S.A.

Girl Scouts of the U.S.A. is an informal educational organization dedicated solely to girls. Accepting and nurturing Girl Scout environments encourage girls in small groups to build character and skills for success in the real world. In partnership with trained and dedicated leaders, girls develop qualities that will serve them all of their lives—such as strong values, a social conscience, and the conviction of their own potential and self-worth.

www.gsusa.org/

Hands On Science Outreach

The Hands On Science Outreach (HOSO) program is a nonprofit science enrichment program for children from pre-kindergarten through sixth grade. It is a community based program that stimulates "science in your life" awareness through the fun of active involvement in experiments, games, music and projects. The program provides activities, Adult Leader training and hands-on materials which go home with the children.

www.hands-on-science.org/

IMLS: Institute of Museum and Library Services

The Institute of Museum and Library Services (IMLS) is an independent federal grant-making agency that fosters leadership, innovation, and a lifetime of learning by supporting museums and libraries.

www.imls.gov/

Institute for Learning Innovation

A nonprofit organization committed to advancing the field of free-choice learning through basic and applied research initiatives, active participation in professional organizations, publication and dissemination of findings through workshops, seminars, and presentations, and through the development of innovative projects and materials utilizing the latest and best models of how people learn when they are personally motivated to do so.

www.ilinet.org/

Missouri Botanical Garden

The Missouri Botanical Garden's mission is to discover and share knowledge about plants and their environment, in order to preserve and enrich life. Today, more than 140 years after opening, the Missouri Botanical Garden is a National Historic Landmark and a center for research, education, and horticultural display.

www.mobot.org/

National Park Service

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

www.nps.gov/

New York Hall of Science

The New York Hall of Science houses over 225 exhibits that provide fun learning experiences for everyone. Hands-on exhibits and trained Explainers are available to enrich the museum experience as the visitor discovers the wonders of science. See the physics, chemistry and biology behind everyday life.

www.nyhallsci.org/

Sesame Workshop

Sesame Workshop (formerly known as the Children's Television Workshop) is a nonprofit educational organization committed to maximizing the power of all media as an educational force in the lives of children. Best known as the creators of *Sesame Street*, the Workshop's products include television, online, CD-ROMs, magazines, film, community outreach, and licensing.

www.sesameworkshop.org/

Texas SSI's Informal Science Education Association

The Informal Science Education Action Team of Texas SSI brings together informal science educators—representing museums, zoos and aquariums, state parks, and nature centers—with members from the formal education arena—including classroom teachers, school administrators, regional education service centers, university systems, and parent-family organizations. It is a learning community that represents the state's regional and cultural diversity.

www.tenet.edu/teks/science/stacks/resources/informal_science.html

The Why Files

The Why Files uses news and current events as a springboard to explore science and the larger issues it raises. It also shows science as a human enterprise and a way of looking at the world. Beyond portraying the outcomes of science, the overarching goal of this Web site is to explain the process, culture, and people that shape science.

whyfiles.org/teach/index.html

University of Wisconsin-Extension

The mission of the University of Wisconsin-Extension is to provide—jointly with the UW institutions and the Wisconsin counties—an extension program designed to apply university research, knowledge, and resources to meet the educational needs of Wisconsin people, wherever they live and work.

www1.uwex.edu/

Appendix:

About Parks As Resources for Knowledge in Science (PARKS)

PARKS Program Description

Parks As Resources for Knowledge in Science (PARKS) is a partnership of the National Park Service, the National Park Foundation, the National Science Teachers Association, Ohio State University and ExxonMobil. PARKS supports science education reform through integrating National Park education programs with the National Science Education Standards. The program is also designed to build strong bonds between formal and non-formal educators, supporting both science education and stewardship for park resources.

PARKS Goals:

- Integrate the *National Science Education Standards* into National Park curriculum-based education programs.
- Create a model framework for integrating national education standards into other park programs (for example, history or social studies programs).
- Promote the National Parks as learning laboratories and provide opportunities for students and teachers to use National Park resources to achieve the *National Science Education Standards*.
- Enhance the quality of science education for students nationwide.
- Increase knowledge of, and stewardship for, National Park resources, the National Park System and associated resources.
- Establish Parks as Classrooms® (National Park Service education program) models that can be replicated at other national parks, while fostering the incorporation of the *National Science Education Standards* into existing and future National Park Service education programs.

Thirty-two parks were chosen, through a competitive process, to receive $25,000 grants over a two-year period and send a teacher/ranger team to a *National Science Education Standards* workshop. Four additional parks received $10,000 grants and served as workshop hosts-sites.

Park rangers are working collaboratively with local school systems and teachers to integrate the *Standards* into existing park curriculum-based programs and, in many cases, create new *Standards*-based programs. The National Park Foundation coordinates the program and serves as the fiscal agent for the parks. The National Science Teachers Association provides professional expertise on the *National Science Education Standards*. Ohio State University is evaluating the program on a national level and assisting park teams in designing and conducting local program evaluations.

Community Connections For Science Education

HISTORY AND THEORY YOU CAN USE

Community Connections for Science Education, Volume II: History and Theory You Can Use shows teachers, informal educators, and parents ways to use **all** the resources of a community for teaching children science. You'll find case studies and advice from museums, national parks, youth programs, television and radio, gardens, nature centers, zoos, and more. *History and Theory You Can Use* will help you design a holistic—and authentic—education in science for your child, your students, or your school district.

This book was developed by the National Science Teachers Association and the National Park Foundation—as was the companion title, *Community Connections for Science Education, Volume I: Building Successful Partnerships.* That book offers practical guidance to teachers and community science educators on how to work together to plan successful field trips.

National Park FOUNDATION

NATIONAL PARK SERVICE

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PB160X2 ISBN:0-87355-192-3

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